VOLUME 41
NUMBER 9

SEPTEMBER, 1954

# plating



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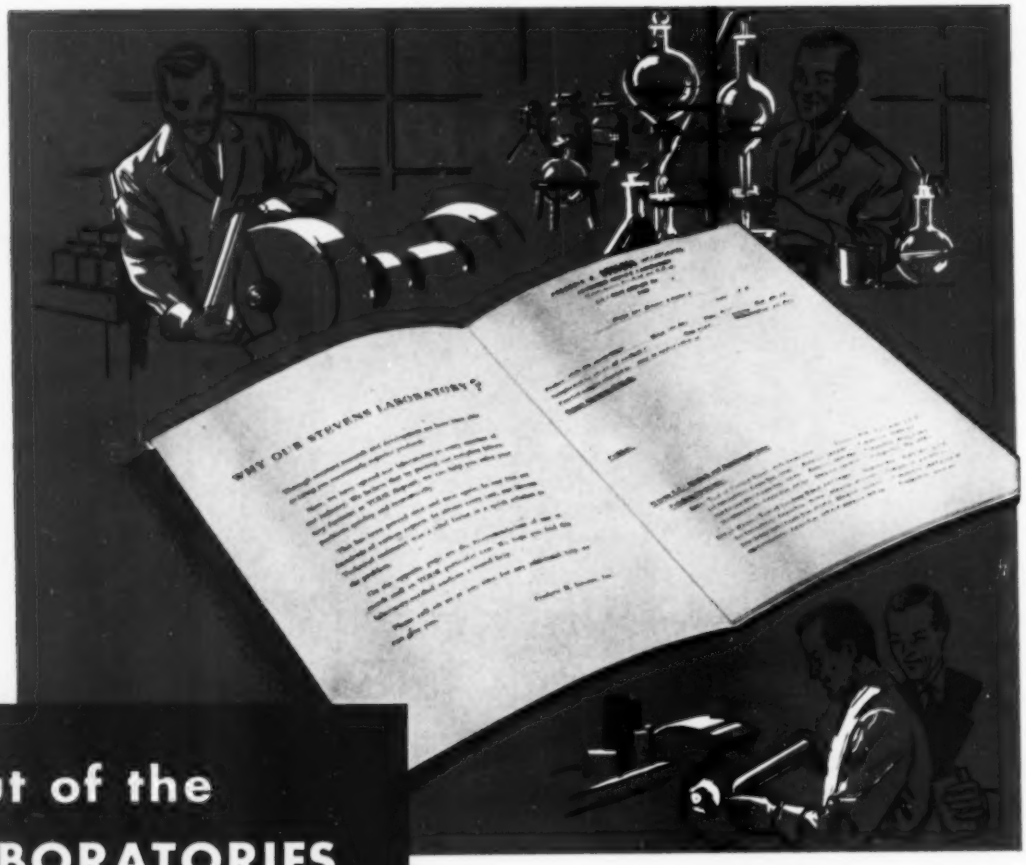

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You can unveil new ways to cut costs and improve your polishing and buffing methods by using the *obligation-free* facilities of the Stevens Customer Service Laboratories. Our Technical Research staff will thoroughly survey your product and prepare a Stevens LV* Report for you. The report will point out the most effective combination of buffs, compositions and equipment to obtain the finish you desire.

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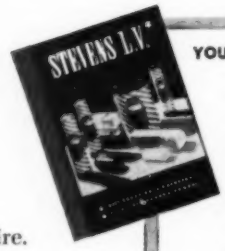


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# plating

September, 1954 — Dedicated to the improvement and dissemination of the knowledge of the arts and sciences of electroplating and of finishing of metals and of allied arts. — Vol. 41, No. 9



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**This Month's Cover . . .**

*shows plastic toy trumpets vacuum metalized with aluminum. Photograph through the courtesy of F. J. Stokes Machine Company, Philadelphia.*


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# Editorial

## The Value of AES to You——Progress

THE FOUNDING FATHERS of the American Electroplaters' Society undoubtedly based their start on the pattern of the American Electrochemical Society, born a few years earlier. Electroplating was a secret and mysterious collection of special brews and dips, operating primarily at room temperature without any definite or precise method of control and bordering on the ancient art of alchemy.

Gold, silver, copper, and nickel were the only prime metals being plated, along with one alloy of variable color and composition — brass. Chemical aftertreatments of all kinds were used to bring about a salable commercial product.

These courageous founders wanted to exchange secrets and bring about a uniform method of control of plating operations. Success was not immediate but rather painfully slow.

An annual meeting on a national basis, together with a quarterly magazine, accelerated progress, which continued slowly but surely through the development of zinc, cadmium, and finally chromium plating. Chromium tipped over the apple cart, guided so carefully during the previous fifteen years, and showed that existing methods of preparation prior to plating required investigation.

This was the start of free exchange of knowledge between individuals, companies, laboratories, and manufacturers concerning their processes and what they could do, not only in the plating room but also in the commercial market. Developments during the past thirty years bear this out.

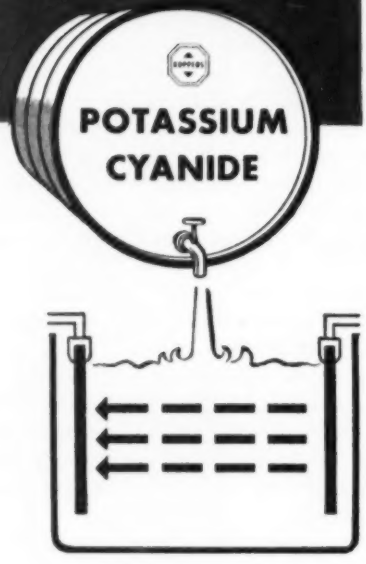
The American Electroplaters' Society through education, meetings, publications, and research has fathered most of these developments and coordinated the work of the chemist, research technician, plater, supplier, manufacturer, and user through friendly cooperation.

Your Society, working for you in the plating industry and related fields, has helped to make your position better today. The value of AES to you today is that it will enhance your progress tomorrow.

George P. Swift

Past President, AES

# How to save money by speeding-up your electroplating operation




If your normal plating operation includes the dangerous and troublesome step of dissolving cyanide granules for the plating bath, plus the time-consuming task of cleaning out so-called "empty" drums of poisonous cyanide powder dust, this proposition is directed to you.

Koppers Potassium Cyanide Solution (35-40%) completely eliminates the dissolving step in your plating procedure. It is available in 55-gallon drums which may be cleaned by a simple water wash. No preparation is necessary. Or it can be delivered to you by tank truck, pumped directly from the truck into your storage tank, ready to use.

Koppers Potassium Cyanide Solution will save you time and labor costs, in addition to minimizing the danger of working with cyanides. Moreover, compared to cyanide granules, Koppers Cyanide solution is moderately priced.

***Potassium Cyanide is one of the many synthetic chemicals produced by Koppers. Others include Resorcinol, Styrene Monomer, Polystyrene, Phthalic Anhydride, Divinylbenzene, and Di-tert-butyl-para-cresol.***

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## *Industry News*

**Free Course in Electroplating.** The course of study in electroplating given at the Brooklyn Evening Technical High School, 29 Fort Greene Place, Brooklyn, N. Y., will begin its fall term on September 15, 1954.

Classroom discussion and laboratory experiments relating to electroplating divide the time for the course. Classroom topics include simple calculations for tank capacities, tank formulas, reading of graphs, and the meaning of Baumé scale measurements. To understand the operation of the tank, a review of the fundamentals of elementary chemistry and series and parallel circuits are discussed.

Additional topics include brighteners, *p*H, wetting agents, buffer agents, pitting, and deionizing. In the laboratory, individual experiments on samples of plating solutions are carried out. Methods of analyses for copper, nickel, chromium, and silver baths are performed by the members of the class. Additional laboratory work covers Hull Cell studies, *p*H meter operation, anodizing, plating on plastics, and thickness measurements.

Registration begins September 13, 1954. Classes meet on Tuesday and Thursday from 6:45 P. M. to 8:15 P. M., plus about six Friday evenings for the term. The term begins September 15, 1954, and ends January 28, 1955. For further information, inquire of Louis Serota, Room BW17 or 3E10.

## Classified Advertisements

Only "Help Wanted" and "Situations Wanted" will be accepted. Rates: $.20 per word, minimum $5.00. AES branch members and members-at-large, in good standing, are entitled to a total of three *free* advertisements in one year. Last day for inserting advertisements is the 10th of month preceding date of publication. When answering advertisements please address as follows: Box number, PLATING, 445 Broad Street, Newark 2, N. J.

**METAL CLEANING EXPERT** for technical field service work. Must be graduate chemist with metal cleaner formulation and field service experience. Willing to travel extensively, salary open, minimum age 35, mid-west location by established industrial chemical manufacturer. *Reply to:*
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**HELP WANTED**
Metal finishing supervisor experienced in polishing, buffing, roto finishing, burnishing and cadmium zinc. Copper, nickel, chrome electroplating. *Reply to:*
P-954-B, PLATING
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# 20 FOOT STAINLESS STEEL TANKS POLISHED WITH LEA COMPOUND

Brewing is one of those processes that requires the utmost in sanitary protection — hence the *stainless steel* for this starting tank being fabricated by the Nooter Corporation of St. Louis for the Anheuser-Busch brewery in Los Angeles, the first all stainless steel equipped brewhall in this country.

Brewers too, insist upon *smooth contact surfaces* which promote maximum efficiency in cleaning and sterilization. No rough spots to harbor food bacteria. And the "spic and span" appearance of smooth gleaming surfaces is of no small importance. Hence the polishing!

In the picture above you see a polisher putting the finishing surface on the interior of one of a group of six 20 foot stainless steel tanks and he's polishing it with one of the many grades of Lea Compound.

The point we want to make is not merely that in the Nooter plant they are using Lea Compound for polishing their stainless steel tanks. It's the technical skill and advisory service available at Lea to help *any* company determine the best polishing and finishing method for each item to be finished. That comes first. All Lea Compositions are of the highest quality but only one composition or series of compositions is likely to be best for any given finishing step. Lea Technicians will be glad to tell you which method and which composition.

Why not let Lea help you with your finishing problem? Write in detail as to your requirements and, if possible, send samples of the work to be finished.

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**POLISHING WHEEL CEMENT**
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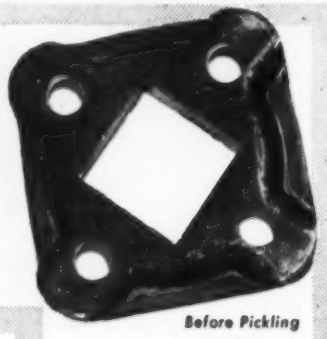
Manufacturing Plant: 237 East Aurora St., Waterbury 20, Conn.

## *Industry News*

**Formax Appoints Weaver Engineering as Southwest Distributor.** Edward W. McAleer, vice-president of Formax Mfg. Corporation, Detroit manufacturer of buffing wheels and buffing compounds, announced the appointment of Weaver Engineering and Supply Co., Inc., Grand Prairie, Texas, as their distributor. A complete factory stock of Formax buffing compounds and Zippo buffing wheels will be warehoused at this location. The president of Weaver Engineering and Supply Company, James E. Weaver, has a well-rounded background of experience in the metal finishing field. Weaver has been associated with National Cash Register Company in their plating laboratory and served as assistant superintendent of the Metal Division, Hickok Manufacturing Company, Rochester, N. Y.

**Improved Facilities at Roto-Finish Co. for Chip and Compound Manufacturing.** To expedite deliveries and improve manufacturing facilities, the Roto-Finish Company announces a new plant addition. The new building is 40 by 80 feet and will be devoted entirely to new machinery and equipment for manufacturing grinding chips and compound. These new manufacturing facilities will improve both the quality of the products and the facilities for handling orders, thus permitting added expediency in deliveries. The new addition will be devoted entirely to machinery and manufacturing equipment and is not intended as a storage building or warehouse. Thus it is expected that the increased production facilities will permit greater flexibility in the handling and delivering of orders. For further information, please write to The Roto-Finish Company, 3700 Milham Road, Kalamazoo, Michigan.


**Acid for De-Scaling and Rust Removal ...of Course! BUT MAKE IT A *Safe* ACID!**



*Before Pickling*

*After Pickling with Magnus D-Scale-RS*

*Use a material that:*

- Stays inert until dissolved in water.
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**USE MAGNUS D-SCALE-RS**

*Write for Bulletin 36 for the whole story on fumeless high-speed de-scaling and de-rusting.*

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**Sustaining Memberships**

Four more organizations have joined the AES Research Sustaining Membership program. The new members are:

**Folding Carrier Corp., 1104 W. Main St., Oklahoma City, Okla. (Unasgnd)**
**Ontario Steel Products Co., Ltd., Chatham, Ont., Canada (W. Ont.)**

**General Electric Opens New Regional Service.** A new combined manufacturing and selling operation to give more direct service to customers in the Midwest has been established at Milwaukee, Wis., by the Industry Control Department of the General Electric Company.

The operation is expected to speed shipments of both standard and specialized control by gearing production more closely to the needs of the region.

Company spokesmen say the operation also will provide job-shop service on special machine-tool controls and other types when needed on a rush basis.

L. J. Geiger, of Schenectady, N. Y., has been appointed manager of Milwaukee Sales, and W. B. Lynn, also of Schenectady, has been named manager of Engineering and Manufacturing.

**Plastic Protective Coatings for Large Metal Structures.** Now large machinery, metal structures and industrial equipment can have the same corrosion-stopping and other benefits by which, for several years, "plastisol" coatings and linings have slashed physical depreciation and maintenance costs of small units. Development of necessary techniques and building of greatly expanded facilities by a pioneer and leader in the field of plastisol coatings has made this possible.

Plastisols are "solutions" of polyvinyl chloride (PVC), a most versatile modern plastic. Developed during World War II, the broad scope of their practical uses is just becoming evident, with new and improved applications constantly appearing.

The developer of services for coating extra large pieces with plastisols is the Arbonite Corp., 900 N. Main St., Doylestown, Pa.

**Adolph Plating, Inc., Acquires Advance Tinning Company.** Robert L. Giesel, president, Adolph Plating, Inc., Chicago, has announced the acquisition of the assets of Advance Tinning Company. The firm will continue its hot-dip tinning operations under Giesel's management without change of personnel or facilities. Carl F. Hansen, formerly president of Advance Tinning, will continue to be associated with the company as technical consultant.

# WHY pay storage and freight on water?

## PROSEAL #9

### a versatile dry chromate powder for better finishes on cadmium and zinc

Here's a single, dry chromate powder than can do a better job on a *variety* of finishes . . . because it is shipped dry — ready for *you* to add the water and acid. There's no need to pay deposits on carboys or expensive freight on water, and there's no need to order a different formula for every job.

Proseal #9 is simple and economical to use—ounces of acid and chromate powder are sufficient to make gallons of *really* protective solution. The bright orange powder can be safely stored, and used as needed, to produce a highly corrosion resistant film for the following finishes:

FOR ZINC • **Bright or Bronze and for zinc Die Cast Bronze**

FOR CADMIUM • **Bright, Dark or Light Gold**

FOR BRASS • **a passivating treatment**

All of PROMAT chromates, in dry or liquid form, meet government specifications as to color brilliance and durability . . . But better yet — PROMAT service assures you that they meet *your* specifications to the letter! Take advantage of PROMAT know-how. Write for details, see how a *proven* product, sensibly specified, and tested on *your* product can help cut costs and give you a better finish!

**PROMAT**

**DIVISION**

**POOR & COMPANY**

**851 S. Market St., Waukegan, Ill.**

## *Industry News*

Giesel is vice-chairman of the Chicago Electro-Platers Institute, and chairman of that group's Industrial Relations Committee. Hansen is a former chairman of the Institute and is currently a member of its board of directors, and is secretary-treasurer of the National Federation of Metal Finishers.

**Alert Supply Co. Given Western Distributorship by Wagner Brothers, Inc.** Recently appointed West Coast distributor for Wagner Brothers, Inc., Detroit manufacturers of electroplating equipment and supplies, is Alert Supply Company, Los Angeles, Calif., announced J. D. Tebben, vice-president, Wagner Brothers, Inc.

Alert Supply will also represent Wagner Brothers in Northern California, Washington, and Oregon from their distribution outlets in San Francisco, Seattle, and Portland.

**Ideal Toys Vacuum Metalized Round the Clock.** When you think of volume production of toys, you may think of Ideal Toy Corporation, who modestly admit to being the largest American toy manufacturer—at least in their chosen fields.

And when Ideal Toy thinks of volume production these days, they are very likely to think of their new Stokes 72-inch vacuum metalizer, recently installed at the Hollis, Long Island, factory (photograph is reproduced on this page and on the front cover of this issue). Here the new production unit is operating regularly around the clock, seven days a week, turning out load after load of shiny metal-coated, plastic-base toys, 1200 every hour.

Production ranges from scale-model tanks, half-tracks, submarines, and the toy soldiers and sailors to man them, to junior-size tea sets and silverware, toy trumpets and saxophones. All of these are injection-molded of polystyrene and then vacuum metalized.

The bright metal coating deposited under vacuum in the metalizer is opaque and thus permits these products to be made of scrap plastic from other molding operations. This scrap is reground and reused without regard for color in the toys that are metalized, and thus material cost is markedly low.

The plastic toys are wheeled into the metalizing department in large bins, just as they come from the injection-molding equipment. The first step is to clean them of any residual mold lubricant. Next they

are placed in the jigs which will carry them through all the subsequent finishing operations. Then the toys are given a coat of a synthetic lacquer that produces a smooth surface to receive the metal deposit and also provides a hard, impermeable layer over the plastic base material that prevents out-gassing of solvents or plasticizers during the vacuum metalizing operation.

The toys, still in their jigs, are then transferred into the circular rack that will carry them into the 72-inch diameter vacuum chamber. The tungsten filaments in the center of this rack are given a fresh

"Why accept imitations when the original costs no more!"

JOE-D Specialists in SISAL BUFFS!

It took specialized "know-how" to conceive and create the first patented Bias Sisal Buff! And that same knowledge has been steadily enlarged and improved by the ablest, most experienced staff in the business—concentrating on this type of buff. Today, our modern, efficient plant proudly produces buffs that meet the most exacting requirements of the metal finishing industry. Always insist on *original* quality. Specify JOE-D—America's *finest* Bias Sisal Buffs.

Holders of the original patent on Bias Sisal Buffs—U. S. Pat. No. 2642706

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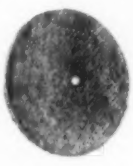

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# World's Finest Anode for Chromium Plating

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"Copper Core" is chemically bonded homogeneously to the lead for its entire length. The entire hook is lead covered for additional protection.

- **This Anode** will conduct 250 amperes based on copper area alone.

Natural flow of current makes entire surface self-cleaning, insuring complete saturation, instant distribution of current, and unusual throwing power. Greatly reduces plating time for a given thickness of deposit.

- **"Copper Core"** distributes current equally throughout the entire length of anode.

The anode is insulated above and below the solution level—which prevents flow of heavy surface currents and burning off at solution line. Conductivity is uniform at all solution levels, regulated only by the cathode depth.

- **"Copper Core"** and point current construction, aids in immediate coverage.

A one-piece copper hook maintains perfect contact —no heating at point of contact, no current failures to solution. "Copper Core" Anodes do not warp out of shape.

## The GILBERT TRAMER Co.

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charge of the small coils of aluminum wire that supply the metal to be deposited on the toys. The fully loaded rack is then rolled into the chamber, the door is closed, and the metalizing operation begins.

A battery of vacuum pumps rapidly evacuate the chamber to a pressure of about ½ micron, the pressure at which vacuum metalizing is most successful. Pumping down to this pressure is automatically controlled from pushbuttons on the control panel of the metalizer and takes from 12 to 15 minutes.

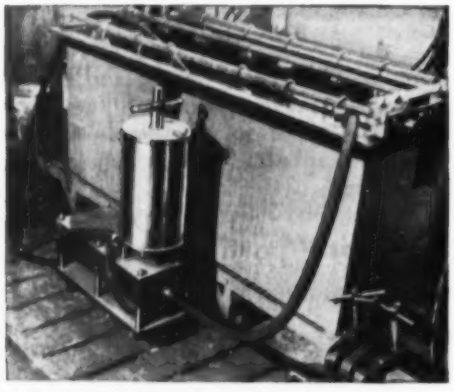
Current in the filaments is gradually raised during the pump-down period, melting the aluminum wire and spreading it out over the filaments as a thin coating of molten metal. When the proper low pressure has been reached, the current is raised rapidly to heat the molten aluminum to the temperature of vaporization, whereupon the metal takes flight in molecular form and travels outward from the filaments so that it thoroughly coats every portion of the surface of the toys within the chamber.

This metal coating deposited on the plastic toys is silvery in color, bright and shiny. It requires no further buffing or polishing to give the desirable real-metal effect.

Immediately after the filaments have been flashed, the vacuum in the chamber is broken and the door is opened. The rack is rolled out, the jigs of finished toys are unloaded, and a fresh load of uncoated toys is rolled back into the chamber for the next cycle. Total time for each cycle regularly runs about 15 minutes.


# Here's how to cut your losses

## get better finished plated work — save time and labor



The "Sealed-Disc" Filter will remove all dirt, dust, and sludge from your plating solutions. You'll no longer worry about pitting, spotting, poor adhesion, formation of nodules, etc.

More and more platers testify to the remarkable savings in operating time and labor that the "Sealed-Disc" Filter gives them. These cost-minded platers get better finished plated work and have found that their solutions last longer. "Sealed-Disc" Filters, designed to meet plating room requirements, are smaller, more compact and portable, than ordinary conventional filters.

Regardless of the size or type of your installation, there's a "Sealed-Disc" Filter to "fit your job." You can depend on a "Sealed-Disc" Filter for positive, trouble-free performance that's proof against even the invisible impurities that cause nodules and porousness, proof against losses caused by rejects and reworking. Write for complete details or contact your regular plating supplier.

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We manufacture a full line of Mixers and Agitators covering a complete range of sizes, for mixing, blending and dissolving. Stainless Steel Mixing Tanks are also available in a wide range of capacities. For full details and illustrations write for your free catalog.


**Pennsalt Chemicals Establishes Canadian Division.** Albert H. Clem, President of the Chemical Specialties Division of the Pennsylvania Salt Manufacturing Company, Philadelphia, has announced the establishment of Pennsalt Chemicals of Canada.

Under an agreement with Canadian Industries, Ltd., who for the past 15 years have handled Pennsalt metal cleaners sales in Canada, this new component will serve its growing Canadian markets through new sales office and warehouse facilities in Hamilton, Ontario.

William B. Billingsley, formerly of CIL and well known in Canadian metal-finishing circles, has been named manager of the new division.

**Austin F. Fletcher, Inc., Formed.** Austin F. Fletcher, Inc., has been formed in Binghamton, N. Y., to sell chemicals, equipment, and metal finishing processes to the metal finishing industry of upper New York State and northeastern Pennsylvania.

This corporation was organized by Austin F. Fletcher, formerly sales and service engineer for Enthone, Inc., New Haven, Conn., in this same area. He becomes president and general manager of the corporation, which also includes Warren Fletcher as vice-president.

Plans call for handling a complete line of products, processes, equipment, and basic chemicals for the metal finishing industry. Most of the items will be stocked in Binghamton and Enthonics service on Enthone products will be continued as in the past by Mr. Fletcher and his assistants, supplemented where necessary by Enthone chemists and engineers.

**Geigy Announces Retirement of Mark Weisberg.** Geigy Chemical Corporation announced the retirement of Mark Weisberg, formerly in charge of its Alrose Chemical Company Division in Cranston, R. I. Weisberg founded Alrose in 1935. After its acquisition by Geigy in 1949 he continued as its president until it became a division of Geigy on March 30 of this year.

Alrose products are sold by Geigy Industrial Chemicals, a newly formed division of Geigy Chemical Corporation, with headquarters in New York.

**Germany to Share Latest Clad-Metals Developments with Knapp Mills of New York.** After a year of intensive technical investigation, Aug. Schnackenberg and Company, Germany's leading producer of lead chemical equipment, and Knapp Mills, Inc., of New York, world's largest producer of Ferrolum lead-clad steel and Cupralum lead-clad copper, concluded in August an 18-year license agreement whereby the German firm employs Knapps's patented processes and know-how for the production of lead-clad metals in Germany.

# Wagner Brothers' laboratory, in close cooperation with the research staff of a leading Mid-Western university, has now developed a vastly superior **BRIGHT NICKEL PROCESS** unsurpassed for trouble-free operating characteristics and luster of finish

# ...IT'S NEW!

Wagner Brothers' NEW WABRITE Bright Nickel Process now offers you exceptional EASE OF CONTROL in plating to reduce rejects and maintenance costs, increase production. HIGH TOLERANCE for IMPURITIES permits sparkling finishes even with a high degree of solution contamination. CONVERSION of present baths to WABRITE is easily done—and without loss of nickel bath or original primary brightener. PITTING is EFFECTIVELY CONTROLLED by lowered surface tension of the solution. UNIFORM PLATE DEPOSITION into recesses is easily accomplished due to the EXCELLENT THROWING POWER (up to 100 amps/sq. ft.). LEVELING and HIDING characteristics of WABRITE are unmatched.

Additives need only infrequent replenishment, are extremely stable. Active WABRITE nickel provides a surface ideal for subsequent chrome plating.

Wagner Brothers' laboratory facilities are available for periodic solution checks to maintain your nickel bath at highest efficiency.

Let us demonstrate the obvious superiority of the Wagner Brothers NEW WABRITE Bright Nickel Process. Mail coupon for additional information.

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**BRIGHTER FINISH**
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Please send more information describing Wagner Brothers Wabrite Bright Nickel Process.

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# NOW you can get this brilliant finish directly on zinc die castings!

**No electroplating--no mechanical finishing!**

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TREATED WITH NEW IRIDITE

## NEW IRIDITE® (Cast-Zinc-Brite)

**brightens zinc die castings by chemical polishing, protects against corrosion**

**NOW, FOR THE FIRST TIME** you can get a brilliant, decorative finish directly on zinc die-cast parts . . . without mechanical finishing, without electroplating! The luster is provided by the *chemical polishing* action of new Iridite (Cast-Zinc-Brite) solution. Even surface blemishes, such as cold shuts, are brightened by this new process. No electrolysis. No special equipment. No specially trained personnel. Just a simple chemical dip for a few seconds and the job is done. And, this new Iridite has been *tested and proved* in production.

**CORROSION RESISTANCE, TOO!** New Iridite (Cast-Zinc-Brite) provides exceptional corrosion resistance for bright-type chromate finishes . . . also guards against blueing or darkening by eliminating zinc plate formerly required in bright chromate finishing of zinc die castings.

**AS A BASE FOR ELECTROPLATING**—Lower mechanical finishing costs are possible where plated finishes are *required* since the brightness provided by this new Iridite may be sufficient.

**LET US SHOW YOU what Iridite (Cast-Zinc-Brite) can do for you. Send us at least a half-dozen typical zinc die-cast parts for FREE PROCESSING for your own tests and evaluation. Or, for immediate information, call in your Iridite Field Engineer. He's listed under "Plating Supplies" in your classified 'phone book. *IMPORTANT: when you give us samples for test processing, please be sure to identify the alloy used.***

Inquire re approved metal government specifications

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## *Industry News*

Lead-clad steel and lead-clad copper have been steadily supplanting other corrosion resistant materials in the chemical and nuclear industry, thus resulting in the need for new mechanical processes to supply the continually increasing tonnages of lead-clad metals, according to the German licensee, whose plant is located in Wuppertal in the heart of the Ruhr.

Included in the contract are four commercial processes not previously disclosed, one of which according to Alfred P. Knapp, president of Knapp Mills, Inc., may also be significant in the production of lead pipe and other forms of lead previously extruded under thousand-ton pressures. Another basic process included in the agreement with the German firm is an automatic lead-cladding machine, originally invented by the American Viscose Corporation and now being commercially developed by Knapp Mills.

In commenting on the importance of West Germany's industry to the free world, Knapp pointed to the growing evidence that lead-clad metals are steadily assuming a key place not only in the production, distribution, and employment of severely corrosive acids and chemicals but as the best means to prevent the escape of dangerous radioactivity. Hence, it is essential that German industry possess the latest and most advanced processes and know-how related to lead.

**American Nickeloid Announces Staff Changes.** With the closing of its Detroit office, the American Nickeloid Company, Peru, Illinois, announced that the Michigan and Northern Ohio territory, formerly serviced by Marc F. Hermann out of Detroit, will be serviced by Carl D. Lenz from the firm's Chicago office. Hermann is now in charge of the company's newly opened Philadelphia sales office. In addition to this new territory, Lenz also services Indiana and some of the Chicago territory.

Back from a tour of duty with the Army, G. R. Storkman, who previously worked out of the Peru, Illinois, office, has been added to the company's sales staff in New York.

**Wiretex Appoints New Representatives.** Wiretex Manufacturing Company, 40 Mason Street, Fairfield, Conn., manufacturers of wire-mesh baskets, retorts, muffles, grids, screens, and racks for quenching, carburizing, salt baths, and dry heat applications has appointed Troutman Associates, Box 613, Louisville, Ky., as their sales representative to cover Indiana, Kentucky, Tennessee, Southwestern Ohio, and certain counties in Illinois.

Also appointed is the H. W. Paret Company for the territory of Western Pennsylvania and Eastern Ohio. Their main office is in Sewickley, Pa., with a post office address of Box 16.

# NEW DEVELOPMENTS in metal finishing

• Increase efficiency • Improve quality

## Apply them to your department

**CHECK** this list of new Pennsalt products that are now saving time and money in metal finishing departments from coast to coast. They are typical of the many different metal finishing products developed by Pennsalt research and thoroughly plant-tested before they are put on the market.

☑ **DOUBLE-BATH SOAK CLEANERS**

Pennsalt Cleaners 45 and 39 remove tough, impacted, drawing compound soils, prior to porcelain enameling.

☑ **HIGH-TEMPERATURE EMULSION CLEANER**

With high flash point and low vapor pressure Pennsalt EC-54* allows greater cleaning efficiency through all temperatures up to 212°F.

☑ **ELECTROLYTIC CLEANER**

K-8* cleans and prepares metals prior to electro-plating. Excellent smut removal properties.

☑ **ALUMINUM "PACKAGE"**

Pennsalt offers you a complete group of products for cleaning, etching, deoxidizing and desmutting of aluminum prior to anodizing or final finishing.

☑ **SUPERIOR PAINT BOND WITH HIGH CORROSION RESISTANCE**

Pennsalt Fosbond® Process anchors a phosphate coating on steel or zinc as a base for paint or other finishes. Fosbond Process includes Actidip®, the amazing activator which reduces solution consumption up to 40%.

For complete information on the products that fit your particular needs, fill in the coupon below and mail it today.

**EC-54 and K-8 are Pennsalt Trademarks*

**Pennsalt Chemicals**

**PENNSYLVANIA SALT MANUFACTURING COMPANY**

East: 811 Widener Bldg., Philadelphia 7, Pa.

West: Woolsey Bldg., 2168 Shattuck Ave. Berkeley 4, Calif.

Metal Processing Dept.
PENNSYLVANIA SALT MANUFACTURING CO.
EAST: 844 Widener Bldg., Philadelphia 7, Pa.
WEST: Woolsey Bldg., 2168 Shattuck Ave., Berkeley 4, Calif.

☐ Yes! I would like technical bulletins on the Pennsalt products for metal cleaning checked below.

☐ Yes! I would like a Pennsalt Service Man to call and discuss the application of these products in our metal finishing department.

☐ 45 and 39 Double Bath Soak Cleaners
☐ K-8 Electrolytic Cleaner
☐ Aluminum "Package"
☐ EC-54 High-Temperature Emulsion Cleaner
☐ Fosbond Process

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# Personals

**Carl C. Clabaugh** of the metal cleaner department of Cowles Chemical Company, Cleveland, has been promoted to the newly created position of sales manager of that department, **Earl F. Clark,** manager of the department, announced recently.

Clabaugh

Clabaugh, who has been associated with Cowles for two years, has been assistant manager of the metal cleaner department for the past year. The newly designated position will give him full authority, in the field, to make decisions dealing with metal cleaner department personnel and policies, Clark stated.

After attending Michigan State College, Clabaugh served as a chemist for a large electrical products company and was a technical sales representative for a chemical manufacturer before joining Cowles early in 1952.

**Burchard M. Day** has been appointed to the position of advertising manager for the Carborundum Co.

Day

Day comes to Carborundum from the McGraw-Hill Publishing Co., New York City, where he has served as assistant promotion manager for *Business Week* since 1952. He brings to his new position a background of valuable training and experience gained in independent newspaper publishing, copy writing, the handling of consumer advertising accounts, and sales promotion.

**Quentin S. Stump** has been appointed national sales manager for Lord Chemical Corporation, manufacturers of chemical compounds, tumbling barrels, and media for all precision barrel finishing, York, Pa.

# Sel-Rex Bright Gold Process

has become

## THE NEW "GOLD STANDARD"

Here Are The Advantages Sel-Rex Offers To You —

- It requires no scratch brushing or buffing for a mirror-bright finish.
- Its greater throwing power gives more protection with less gold.
- It gives 40% more resistance to wear and abrasion.
- Directly over steel, it gives six times greater protection with ¼ the amount of gold, in salt spray tests under standard ASTM conditions.
- It is twice as hard as conventional gold plating.
- It does not alter or deform surface contours because of smoothness of deposit.

Sel-Rex Bright Gold solution is easy to maintain, and operates at room temperature. No special equipment is required. Hundreds of successfully operating installations, both decorative and industrial, have proven the superiority of the new Sel-Rex Bright Gold Process.

**SEL-REX PRECIOUS METALS, INC.**

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PRECIOUS METALS SALTS AND SOLUTIONS FOR THE PLATING INDUSTRY

## *Personals*

Stump began his sales career in 1937 as sales manager for a packaged food producer. In 1948 he left to become president of his own company, the Hill Electroplating Company, York, in charge of management and sales.

Stump joined Lord Chemical in 1952 as a sales engineer.

**Frederick S. Foster** has been promoted to the position of manager, Industrial Chemicals Department, Apothecaries Hall Company.

Foster is a graduate of DePauw University, Greencastle, Ind., class of 1932, where he majored in chemistry. He received a B.A. degree and was elected to Phi Beta Kappa. He took one year post graduate work at Colgate University.

Foster has been associated with Apothecaries Hall Company since 1934. He worked in the company's analytical and research laboratory for seven years. He was in charge of allocations and priorities for three years. For seven years Foster

Foster

Voyda

was in the sales department, and from 1948 to 1951 served in the capacity of sales engineer.

Since July, 1951, Foster has been assistant to the vice-president.

**Theodore Z. Voyda,** chief chemist of Apothecaries Hall Company since 1946, has been named technical director effective June 2, reporting to the president. Voyda is a University of Connecticut graduate where he received a B.S. degree in 1939 and M.S. degree in 1944.

Voyda has been engaged in metal finishing activities for the past 14 years and was formerly supervisor of electrochemical research and development at Pratt and Whitney Aircraft in east Hartford. He is a member of the American Electroplaters' Society, the Electrochemical Society, the American Chemical Society, and Sigma Xi, honorary scientific society.

**Hugh V. McGuire** will be in charge of all sales engineering relating to engineering and installation activities for the Hanson-Van Winkle-Munning Company.

McGuire

McGuire returns to H-VW-M after a year of intensive experience in the metal finishing equipment field. Previously he was with H-VW-M for 13 years. He was a general equipment sales engineer and specialized in metal finishing plant layout.

His background with H-VW-M also includes experience in the export field and with graphic arts installations.

He is a graduate of Rutgers University and has undertaken subsequent studies relating to his work in the engineering and installation of metal finishing equipment.

**M. A. Wegenhart** of Madira, Ohio, has been appointed a representative of the Chemical Corporation, Springfield, Massachusetts, and will cover the states of Ohio, Indiana, Michigan, and Kentucky.

Wegenhart will handle sales of Pla-Tank brand chemical resistant reinforced plastic materials to the electroplating and chemical processing industries in these states.

**Vance N. Wilson** has been appointed manager of the new Pennsylvania Salt Manufacturing Company plant at Chicago Heights, Ill., for which ground was broken on July 8. Announcement of his appointment was made this week by **Albert H. Clem,** president of the Chemical Specialties Division, under which the new plant will operate.

Wilson, a native of Fairmont, W. Va., holds Bachelor of Arts and Master of Business Administration degrees from the University of Michigan. He started his

USERS of Unichrome Coating 218X know that in Unichrome Primer 219PX they're getting the outstanding *single coat primer* developed. It not only saves time and work, but also assures maximum benefits from the remarkable properties of Coating 218X.

Anchored to this primer, Coating 218X takes hard use – even abuse. It defies all plating and cleaning cycles without blistering, or lifting at contacts. It won't crack, chip or tear. It even resists vapor degreasing cycles.

Remember, Coating 218X is produced by United Chromium . . . the company that has: (1) Developed plating processes; (2) Given service on plating problems; (3) Pioneered highly corrosion-resistant plastisol coatings . . . and therefore knows what a rack coating needs for maximum plating service.

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employment with Pennsalt as a student trainee in February, 1941. Later he became supervisor of the company's tank car operations and a supervisor of industrial relations. He was superintendent of the Bryan, Tex., plant from January, 1952, to January, 1954.

**Burton G. Adams** has been appointed sales representative in southern California for the Chemical Specialties Division of the Pennsylvania Salt Manufacturing Company.

Adams will be responsible for the full line of Pennsalt cleaning and metal surface preparations, including the Foscoat and Fosbond processes, and will be available for service to metal finishing companies throughout the southern California area.

A native of California, Adams was recently graduated from the University of California.

**Norman B. Pilling,** since 1939 Director of the Bayonne Research Laboratory of the International Nickel Company, Inc., has recently assumed new duties as Assistant to the Vice-President and Manager of the company's Development and Research Division in New York.

Pilling

Wesley

Born in Waterbury, Connecticut, Pilling received his Bachelor of Philosophy degree from Yale University in 1915 and a Master of Science degree in 1917. From 1917 to 1924 he was research metallurgist for Westinghouse Electric and Manufacturing Company, East Pittsburgh. He served as research metallurgist for Inco from 1924 until 1933, when he was appointed Manager of the Bayonne Research Laboratory.

**Dr. W. Andrew Wesley,** Assistant Director since 1939, succeeded Pilling as head of Inco's Bayonne Research Laboratory, with the title of Manager.

Wesley became a member of the staff of the research laboratory in 1926 as a research chemist. A native of Yonkers, New York, he received a Bachelor of Chemistry degree from Cornell University in 1923, a Master of Science degree from New York University in 1924, and became a Doctor of Philosophy at the same university in 1926. A member of several technical organizations, he has been particularly active in the American Electroplaters' Society, heading the Research Committee in 1950–1951.

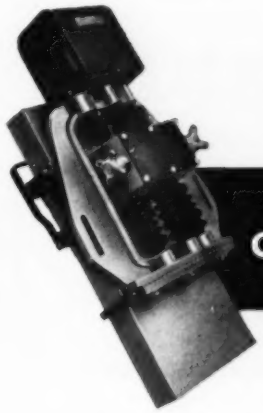
Among the honors he has received in recognition of his work are two awards of the AES Gold Medal in 1939 and 1950, the Founder's Gold Medal in 1949, the AES Silver Medal in 1952, and a cash prize in 1943.

Eash

**Dr. John T. Eash,** Metallurgical Supervisor and head of the Ferrous Castings Section of the Inco laboratory, became Assistant Manager.

Born in Albany, Indiana, Eash received a Bachelor of Science degree in chemical engineering in 1928 from Purdue University, a Master of Science degree in engineering in 1929, and a Doctor of Philosophy degree in metallurgical engineering in 1932 from the University of Michigan. While at Michigan he was employed in the Department of Engineering Research and he also held the position of teaching assistant.

In July, 1931, Eash joined the research laboratory of International Nickel as a metallurgist in the precious metals section and later conducted research on nickel alloys, bronzes, cast iron, and steel. Between 1935 and 1950 he held in succession the positions of Section Head of the Iron and Steel Section, the Ferrous Castings Section, and the Nonferrous Section. Since 1950, Eash has been Metallurgical Supervisor and head of the Ferrous Castings Section.

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A NANKERVIS COMPOUND APPLICATOR FOR 10-INCH BARS

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Buffing l-a-r-g-e parts? Then here's a product to help you get better results, cut costs as well.

It's the new Nankervis Automatic Compound Applicator. Called the Model 610, the new applicator accommodates any cake up to 10 inches wide (2"x10"x24").

It is automatic in operation and is similar in construction to other models in the "600" Series. Air operated, it weighs forty pounds and can be installed on all types of buffing machines. All moving parts are bearing mounted to insure smooth operation and long life. Protective boots of molded Neoprene seal out all dirt, dust, lint and compound from the operating mechanisms.

Nankervis "600" Series Applicators can be operated from any air supply line equipped with a 3-way exhaust valve. This valve can be mechanically, electrically, or manually-operated depending on the buffing operation involved and the amount of compound desired. Each time the air valve is operated, the cake holder is thrust forward applying compound to the buff. The cake holder retracts, when the valve is released, pulling the compound away from the buff. Each time the cake holder is thrust forward, its relative position is advanced to compensate for wearing of the bar. This feed rate is adjustable from .0015" to .015" per stroke. (No 3-way valve is supplied as the choice of this component is dependent on the buffing operation involved.)

Instructions for installing, operating, and maintaining the applicator are included with each unit.

*For Additional Information* on This and Other Nankervis Applicators Write for Nankervis Technical Bulletin No. 600.

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EQUIPMENT AND SUPPLIES FOR THE METAL-FINISHING INDUSTRY




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**Phillip Borell** has been appointed representative of Allied Research Products, Inc., in the eastern Pennsylvania and adjacent New Jersey area. Borell will make his headquarters at Room 1123, Western Saving Fund Building, Broad and Chestnut Sts., Philadelphia.

**Dean Ward** will continue to handle the major New Jersey territory.

**J. A. Cairns** has moved to the home office of the corporation to handle special project sales.

**Nicholson Named Stokes Export Product Manager.** Charles V. Nicholson has joined F. J. Stokes Machine Co., Philadelphia, as export product manager. Under A. A. Hutchings, Stokes vice-president in charge of sales, Nicholson will supervise all phases of Stokes export sales activity within the company's present distribution structure.

A native of Pittsfield, Mass., Nicholson was graduated in 1933 from the Wharton School of Finance and Commerce, University of Pennsylvania, with a B.S. in Economics. He joined Henry Disston and Sons, Inc., in December, 1936, as a junior salesman and sales promotion representative for both hardware and industrial products and has been with Disston ever since until joining the Stokes organization.

During World War II, Nicholson enlisted in the U. S. Air Force, rising to the rank of captain. He is now a major in the Air Force Reserve.

**W. Beckhardt** is the new technical service representative in the Norristown, Pa., area for Oakite Products, Inc., manufacturers of industrial cleaning and metal treating materials.

Beckhardt, who was formerly with the Eastern Tank Maintenance Co. of Philadelphia, completed an intensive eight-week training course at the company's New York headquarters and in the field before taking up his new assignment.

Beckhardt

Spratt

**Jerome E. Spratt** is the most recent addition to the Los Angeles staff of Oakite. For the past fourteen years, Spratt has been with the Mission Appliance Corporation in Hawthorne, where he was manager of the finishing department. A resident of Downey, he will serve the metal working industries in East Los Angeles, Alhambra, Glendale, and South Pasadena. Spratt also recently completed the intensive eight-week training course.

**William J. Fabish** has been appointed eastern representative of Hammond Machinery Builders, Inc., Kalamazoo, Mich., builders of Duskolectors and grinding, polishing, buffing, and deburring machinery.

Fabish

Fabish, who has served the metalworking industry in the East for the past 12 years, will represent the company for the complete line of machinery. His home address is 92 Willow Street, Garden City, New York.

**Robert A. Stauffer,** vice president in charge of research of the National Research Corporation, announced that **Dr. David I. Sinizer** has joined the staff of the Metallurgical Research Department.

Sinizer, who will be a project manager, attended Columbia University, where he received his A.B., B.S., and metallurgical engineering degrees. He received his Sc.D. at the Massachusetts Institute of Technology.

Sinizer has gained wide experience in both ferrous and nonferrous physical and process metallurgy. He has been associated with the Inland Steel Company,

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**ELECTRO-FINISHING RESEARCH, INC.**

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**3. KER-CHRO-MITE No. 1** for Zinc and Cadmium **costs about:**

$0.001-$0.002/sq-ft, **for brilliant finish**
$0.0003-$0.0005/sq-ft, **for protective finish.**

**4. KER-CHRO-MITE No. 1** needs hardly any control. Good results are obtained at room temperature, and superior results are obtained at mildly warm temperatures.

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Battelle Memorial Institute, Bendix Aviation Company, International Nickel Company, and the Arthur D. Little Company.

**J. C. Miller** and **G. H. Walgren** have been elected to the board of directors of the Hanson-Van Winkle-Munning Co., Matawan, N. J.

**Miller** **Walgren**

Miller, until his organization became a division of H-VW-M, was chairman of the board of the J. C. Miller Co., Grand Rapids, Mich., which he founded in 1920. Walgren, who has been with J. C. Miller for more than 18 years, was president of this company.

Walgren has been appointed vice-president of H-VW-M and has been placed in charge of J. C. Miller Division. The facilities and policies which have accounted for the success of the J. C. Miller Company will be continued.

Other appointments to the management team of the Miller Division include **J. A. Badalucco** as assistant general manager; **F. W. May** as manager of sales; and **C. E. Jackson** as purchasing agent. All of these men were with Miller in similar capacities for many years.

**Dr. Harry Walker** has been appointed vice-president of the Norma-Hoffmann Bearings Corporation, Stamford, Conn., in charge of the newly formed Walker division which engages in the manufacture and sale of selenium and other types of dry disc rectifiers.

**Arthur P. Schulze** has been named manager of public relations and advertising of Diamond Alkali Company, Cleveland, Ohio.

Schulze joins the Diamond organization from Hill and Knowlton where for the past seven years he has been engaged in publicity and public relations for this leading producer of basic chemicals and several other industrial concerns.

Under the supervision of a company executive, he will be responsible for directing and coordinating Diamond's public relations and industrial advertising programs, working in cooperation with the company's public relations counsel, Hill and Knowlton, and its advertising agency, Fuller and Smith and Ross.

**Oscar E. Kuhlman,** who has been editing Diamond's Painesville plant employee publication for the past three years, has been promoted to assistant manager of public relations and advertising. He will be located at the company's general headquarters in Cleveland.

A Clevelander, Schulze is a journalism graduate of the University of Missouri, and at one time was a reporter on the Elyria (O.) Chronicle-Telegram. An active member of the Public Relations Society of America, Sigma Delta Chi, and the International Council of Industrial Editors, he also has contributed articles to many national industrial magazines during the past 10 years.

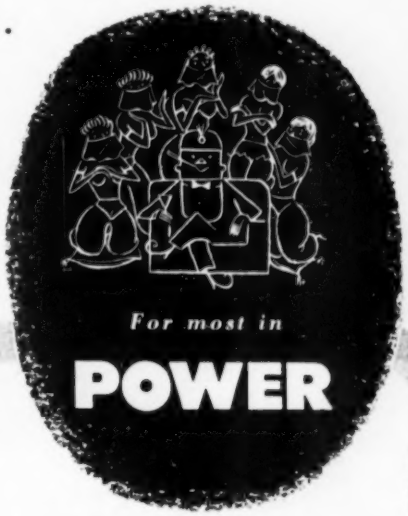
Schulze's experience in industrial publicity, advertising, and sales promotion, dating back to 1936, includes six years prior to World War II in the advertising field. Following two and one-half years' military service with the U. S. Army Quartermaster Corps, Schulze became publicity director of Taber Instrument Corporation, North Tonawanda, N. Y.

**Robert L. Kaiser** has been named marketing development manager of Magnus Chemical Co., Inc., Garwood, N. J. He will concentrate on sales planning, training, and sales promotion coordination.

Kaiser holds an A.B. degree in economics from Dartmouth College, from which he graduated Phi Beta Kappa and second in his class. Prior to five years as a Field Artillery officer in World War II he was with N. W. Ayer & Son, advertising agency.

Since 1946, Kaiser has managed the Dif Corporation, manufacturer of consumer cleaning specialty products and closely affiliated with Magnus. He is now executive vice-president and general manager of the Dif Corporation and the Larkin Soap Co., wholly owned subsidiary of Magnus. Kaiser will continue in these positions with Dif and Larkin, in addition to taking on his important new job in Magnus.


***Foremost in Quality . . .***




Sel-Rex

*Completely Sealed*

**SELENIUM RECTIFIERS**

**If a manufacturer intends to maintain a prominent position in a highly competitive business, his production equipment must be the most modern and efficient made.**

**SEL-REX places no limitation on engineering to achieve the finest DC power plant . . . nor compromise in the choice of component parts to "bring the cost down." True, such a policy may reflect a slightly higher initial cost . . . but in the long run a SEL-REX UNIT is the most economical. There are no moving parts to wear out — no maintenance expense, no loss of production.**

**SEL-REX RECTIFIERS available for every requirement from 25 to 50,000 amperes including completely sealed water cooled and air cooled models.**

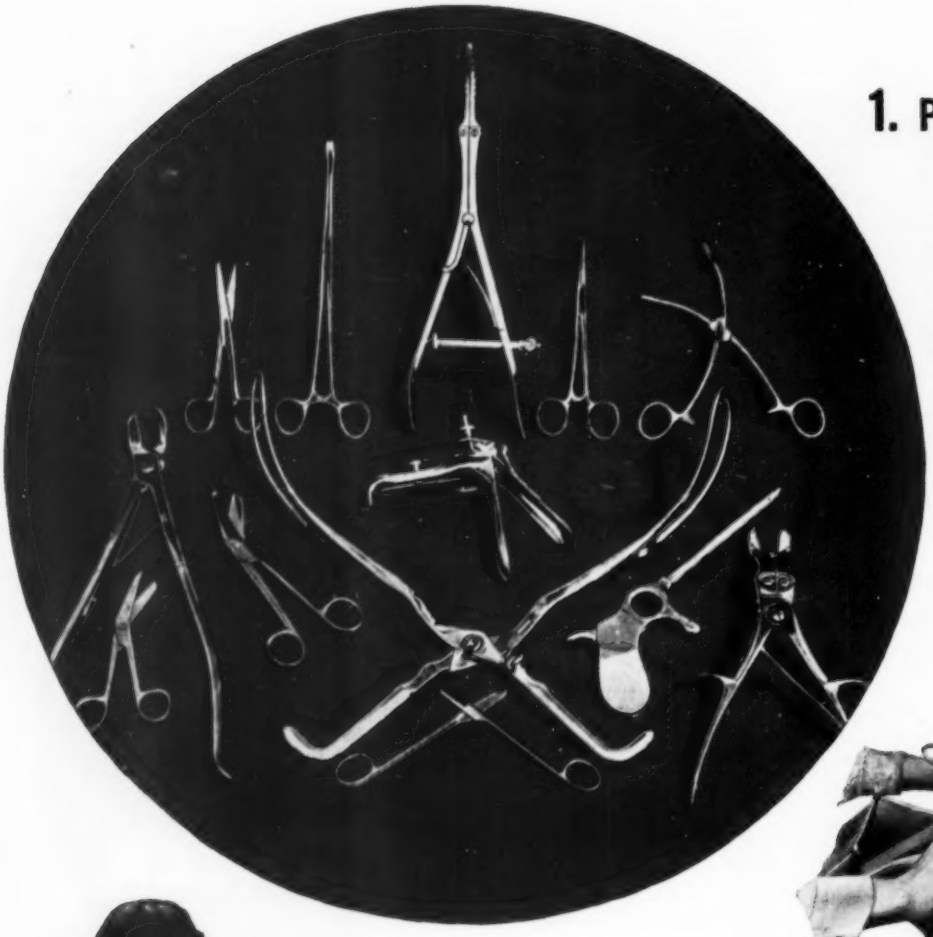
*Write for complete details.*

NEMA

**BART-MESSING CORPORATION**

**Dept. PL-9 229 Main Street, Belleville 9, N. J.**

# HOW WOULD YOU SOLVE IT?



## 1. PRODUCTION PROBLEM:

To produce a more uniform finish on the multiple contours of stainless steel surgical instruments and cut unit costs of finishing and polishing. Witte & Schmitz Surgical Instrument Co. was using set-up wheels which left unsatisfactory finishes, tired operators.

## 2. SOLUTION:

A 3M Representative suggested that this Bridgeport, Conn. manufacturer switch to the 3M Backstand Method using Three-M-ite "Resinite" and Three-M-ite Cloth Belts. A 3M Methods Engineer helped the firm make up their own spindles and mounted wall idlers to make best use of limited space.

## 3. RESULTS:

An immediate 25% production increase with a far superior finish on the instruments. Too, the manufacturer found that unskilled workers could be trained to polish the multiple contours more rapidly, and there was less operator fatigue. 3M Representatives can help solve *your* grinding problems, too. Send coupon for facts.

### WANT MORE INFORMATION?

Minnesota Mining & Mfg. Co.
Dept. PL-94, St. Paul 6, Minn.

☐ Send me free booklet: "Case History Reports on 3M Abrasive Belts."
☐ Have 3M Representative call.

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

3M ABRASIVES

Made in U.S.A. by Minnesota Mining & Mfg. Co. General Offices: St. Paul 6, Minn. In Canada: London, Ont., Can., Export: 122 E. 42nd St., New York City. Makers of "Scotch" ® Pressure-sensitive Tapes, "Scotch" ® Sound Recording Tape, "3M" ® Adhesives, "Underseal" ® Rubberized Coating, "Scotchlite" ® Reflective Sheeting, "Safety-Walk" ® Non-slip Surfacing.

# Trade Literature

**L—900. Revolutionary Concept in Plating Automation**—Presented in easily read editorial style, Bulletin B 50-54 describes a revolutionary concept in plating automation as used in the fully automatic plating machine of Wagner Brothers, Inc., Detroit.

The bulletin contains a comprehensive explanation of the unique parts transfer and conveying principle that permits highly efficient processing of parts through the entire plating cycle with half the labor and power requirements of ordinary automatic platers of comparable size, according to the company. Secure a free copy by using Reader Service Card.

**L—901. Coated Abrasives**—A two-page leaflet has just been published by Behr-Manning Corporation, Troy, New York. The leaflet describes the new additions to the company's abrasive tools. For a free copy, use Reader Service Card.

**L—902. Fine Wire, Foils, and Ribbons Booklet**—The Baker and Company, Inc., Newark, N. J., has available a new four-page booklet on its products—extruded, Wollaston, Taylor Process, and resistance wires and metallic ribbon and thin foil, all manufactured in various precious metals. Get your free copy by using Reader Service Card.

**L—903. Engelhard Universal Gas Analysers**—Charles Engelhard, Inc., East Newark, N. J., manufacturers of industrial instruments, has a new four-page folder on gas analysers for thermal conductivity measurements. For your copy, use Reader Service Card.

**L—904. Catalog Covers Line of Industrial Protective Coatings**—The Ceilcote Co. has announced the publication of the new 8-page illustrated catalog No. C-150. Purpose of this publication is to simplify the complex problem of selecting the correct protective coating for various industrial installations. A special feature of the catalog is the protective coating properties chart which presents complete information on each coating in concise form. In addition to formulation, temperature resistance, drying time, and coverage, the ability of each coating to resist 18 commonly encountered chemicals is indicated. For additional information, use Reader Service Card.

**L—905. New Industrial Rubber Catalog**—Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J., announces the publication of an entirely new edition of its catalog of rubber products for industry. The catalog covers V-belts, transmission belts, conveyor belts, all types of hose, and molded products. It outlines such new R/M products as the revolutionary Poly-V Drive which combines the simplicity of flat belts and grip of V-Belts, eliminating matching and saving space with greater strength. Other new features and products highlighted are R/M Super-Power V-Belts, the "XDC" Conveyor Belt Cover, and the Hydro-Lok Rubber Pipe Flange. For more information, use Reader Service Card.

**L—906. Industrial Waste Treatment**—Advantages inherent in the treatment of industrial waste waters and process liquors are described in a new bulletin, 'Industrial Waste Treatment," just published by the Graver Water Conditioning Company, New York. Schematic drawings, pictures, and a problem-solution-result type of explanation demonstrate how Graver equipment solves such problems as process and cooling water shortages, contamination of streams with plant effluents, and the loss of valuable heating materials in discarded waters and process liquors. Particular attention is given to the petroleum, metal plating, and paper industries. A free copy of this bulletin may be obtained by using Reader Service Card.

**L—907. Laboratory and Industry Chemicals Catalog**—The new LaPine chemical catalog lists prices of laboratory and industrial chemicals in quantities from ounces to hundreds of pounds and from cc's to multiple-gallon drums. After the 32-page alphabetical listing of technical chemicals and laboratory reagents are sections on reagents, staining solutions, *p*H indicators (dry or in solution), aniline, and coal tar dyes.

For a copy of the catalog, use Reader Service Card.

**L—908. Productive Maintenance Bulletin**—General Electric Co., Schenectady, N. Y., announces an 18-page bulletin which gives detailed information on organizing to meet the demands that automation will make on electrical maintenance programs. Steps discussed include: gathering equipment data; determining extent of routine maintenance; establishing a routine operating control system; evaluation for critical maintenance; and establishing a critical maintenance program. For more information, use Reader Service Card.

**L—909. Catalog on Baskets, Tanks, and Trays**—A new catalog has been issued by the Wiretex Mfg. Co., Inc., of Bridgeport, Conn., manufacturers of wire baskets and tanks for industry.


THE Chemical CORPORATION

"KEMO" TECHNICAL SERVICE

where New England turns for reliable service on

DANIELS PLATING BARRELS

- Heil Heat Exchangers and Chemical Resistant Tanks
- Sparkler Filters
- Pennsalt Metal Cleaners
- Chandeysson Generators
- Pennsalt Fosbond and Fos process
- General Electric Rectifiers
- Crown Rectifiers
- Meaker Plating Machines
- Stutz Plating Barrels
- Columbia Ammeters and Rheostats
- Republic Lead Anodes

and sound engineering advice.

THE CHEMICAL CORPORATION

Makers of Luster-on,® Pla-Tank® and Stripode

*Write for our new Metal Finishing Catalog*

54 WALTHAM AVE., SPRINGFIELD 9, MASS.

INDICATE A 1122.

***Each** of these new outstanding Harshaw bright nickel plating processes have certain unusual characteristics which fit them to the product finish required in your plant.*

Top brightness with thin deposits . . . Especially outstanding color performance in applications where little or no basis metal finishing is done prior to plating. . . . Perglow or Nubrite deposits are extremely receptive to chrome plating . . . Unique leveling results of Perglow or Nubrite have a hiding and filling effect on surface defects which other nickel deposits tend to emphasize. Polishing costs are decreased.

***For application in your plant, phone or write our nearest office.***

NEW HARSHAW

# Nubrite

**THE HARSHAW CHEMICAL COMPANY**

**1945 East 97th Street • Cleveland 6, Ohio**

Chicago 32, Ill. • Cincinnati 13, Ohio • Cleveland 6, Ohio • Houston 11, Texas
Los Angeles 22, Calif. • Detroit 28, Michigan • Philadelphia 48, Penna.
Pittsburgh 22, Penna. • New York 17, N. Y.

## *Trade Literature*

The new catalog illustrates a wide variety of wire mesh products and includes sections on baskets, processing and heat-treating equipment, fixtures and crates, tanks, plating, and special equipment.

Among metals and alloys available are nickel, chromium, stainless steel, aluminum, monel inconel, steel, copper, and brass. For additional information use Reader Service Card.

**L—910. Impervious Graphite Immersion Heaters**—A bulletin describing the various types of Impervite heat exchangers, both plate and bayonet type, is announced by the Falls Industries, Inc., Solon, Ohio. For additional information, use Reader Service Card.

**L—911. Wire Rope**—John A. Roebling's Sons Corp. has issued a new publication designed to provide a simplified ordering plan and reference for wire rope users. The catalog is divided into 16 sections, one for each of the major industries which use wire rope. For more information, use Readers Service Card.

**L—912. Agile Chemical Resistance Chart and Pipe Catalog**—A new, 20-page bound booklet includes information regarding the excellent chemical resistance of three thermoplastic construction materials, Agilene (polyethylene), Agilide (non-plasticized PVC), and Agilux (high-impact PVC) at various working temperatures. Numerous inorganic and organic reagents, solutions, solids, and mixtures have been tested and data are based upon actual test results. These three materials can be fabricated by hot-gas welding into various types of chemical processing equipment such as tanks, ducting, centrifugal fans, and valves, for the plating, chemical, and allied industries. For more information, use Reader Service Card.

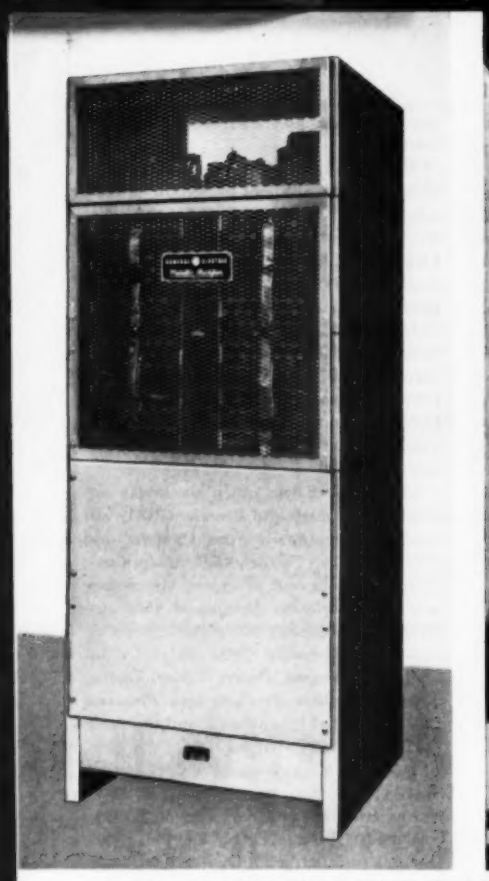
**L—913. New Wash Primer**—A bulletin has just been issued by the Stanley Chemical Co., East Berlin, Conn., containing full details about the application of their new one-package wash primer, 40X-610. According to the manufacturer, this outstanding primer will allow outdoor storage of steel or iron parts for up to one year without topcoating. The bulletin on Stanley 40X-610 may be obtained by using Reader Service Card.

**L—914. Parts Handling Baskets**—Wire & Iron Products, Inc., offer a new bulletin on their line of Ezy-Stak parts handling baskets. The bulletin describes the firm's complete line of standard and custom-engineered baskets. According to the manufacturer, the baskets promote greater efficiency in parts handling and storage, helping to keep rejects at a minimum. The bulletin, No. B-54, is available on request by using Reader Service Card.

**L—915. Vacuum Furnaces**—Vacuum furnaces have added about 30 metals to the industrial spectrum, including titanium, zirconium, germanium, and similar rare metals, as well as the more common copper, iron, and steel in new high-purity forms with properties so greatly improved as to deserve being called new metals.

A new brochure, released by F. J. Stokes Machine Co., Philadelphia, Pa., discusses at length this rapidly growing new field of vacuum metallurgy and includes a comprehensive treatment of the effects of processing various metals and alloys in vacuum. It also includes descriptions, with drawings, of the several types of vacuum furnaces Stokes is now building, with particular emphasis on resistance-heated furnaces with movable heat source, tilting-type furnaces, and movable-retort furnaces. For more information, use Reader Service Card.

**L—916. New Government Publication Announced**—Further encouragement to American industry to take advantage of the products of Government-sponsored technical research is the publication, announced in August by Dr. Archie M.



AUTOMATIC REGULATION IS IN TOP SECTION OF POWER SUPPLY. OPERATOR SETS DESIRED VOLTAGE ON CONTROL STATION NEAR TANK.

# Automatic Regulation on G-E Plating Power Supplies Increases Productivity and Reduces Costly Rejects

Once you have set the voltage or current on an automatically regulated General Electric Plating Power Supply, no further adjustments are needed. Automatic regulation maintains your setting within ±2 per cent, regardless of variations in line voltage or tank load. Equipment is available to automatically regulate voltage or current, or both.

**SAVINGS**—Automatic regulation saves you money several ways. There is no need to check and adjust current or voltage. By eliminating human error, it assures work of more uniform quality. It facilitates continuous production without expensive shutdowns for maintenance or adjustments. Finally, it greatly reduces your rejects caused by current or voltage variations.

**FLEXIBLE**—Automatic regulation will maintain any setting between 16 and 100 per cent of rated voltage, or 10 and 100 per cent of rated current. It is available as an integral part of G-E plating power supplies, or can be added later to manually controlled units.

**MORE INFORMATION** is available from any authorized G-E agent listed, or by writing Section 464-15, General Electric Co., Schenectady 5, N. Y.

**BARREL PLATERS**

Economical, 12-volt barrel platers are available in ratings from 500 to 2000 amperes. Your nearest agent has full information.

**G-E PLATING POWER SUPPLIES ARE SOLD BY THESE AUTHORIZED AGENTS:**

AMERICAN FACTORS LTD., Honolulu, T. H.
M. E. BAKER CO., Cambridge, Mass.
BELKE MFG. CO., Chicago, Ill.
WILLIAM BUCHANAN SUPPLY CO., Cincinnati, Ohio
THE CHEMICAL CORP., Springfield, Mass.
CLEVELAND ELECTRIC CO., Atlanta, Ga.
CONNECTICUT ELECTRIC EQUIPMENT CO., INC., Meriden, Conn.
ENTHONE CO., New Haven, Conn.
FITZPATRICK ELECTRIC SUPPLY CO., Muskegon, Mich.
W. M. FOTHERINGHAM CO., Buffalo, N. Y.
GENERAL ELECTRIC SUPPLY CO., Cleveland, Ohio
FRED GUMM CHEMICAL CO., Kearny, N. J.
J. & H. ELECTRIC CO., Providence, R.I.
LASALCO, INC., St. Louis, Mo.
LEA MANUFACTURING CO., Waterbury, Conn.
A. J. LYNCH & CO., Los Angeles and San Francisco, Calif.
WILLIAM LYNN CHEMICAL CO., INC., Indianapolis, Ind.
MEAKER CO., Cicero, Ill.
CARL F. MILLER CO., Seattle, Wash.
J. C. MILLER CO., Grand Rapids, Mich.
GEORGE L. NANKERVIS CO., Detroit, Mich.
REYNOLDS-ROBSON SUPPLY CO., Philadelphia, Pa.
STANDARD PROCESS CORP., Chicago, Ill.
STANDARD WHOLESALE SUPPLY CO., Las Vegas, Nev.

*Progress Is Our Most Important Product*

GENERAL ELECTRIC

## Trade Literature

Palmer, Chairman of the Government Patents Board, of a volume listing 775 Government-owned inventions in the field of instrumentation, with a brief description of each invention.

Palmer pointed out that these inventions are ordinarily available to the public on a royalty-free license basis. In addition to the brief description or abstract of the invention, each listing includes the patent number, the title of the invention, name of the inventor, and the Government agency administering the patent.

The 775 listings in the book, entitled *Instrumentation*, are classified under eight country, which may be consulted concern-subgroups to help readers quickly locate items of particular interest. These subgroups are: laboratory, scientific, and engineering instruments; instruments for indicating, measuring, and recording electrical quantities and characteristics; mechanical measuring and controlling instruments; optical instruments and lenses; surgical and medical instruments; X-ray and therapeutic apparatus; surgical and orthopedic appliances and supplies; photographic equipment and supplies.

Also listed in the book are the addresses of the field offices of the United States Department of Commerce and of the Small Business Administration, conveniently located in various parts of the ing the availability and use of these inventions.

This volume is the first of a series of seven on Government-owned inventions scheduled for publication this year under the joint sponsorship of the United States Department of Commerce and the Small Business Administration. This series of publications was prepared from the records of the Index of Inventions, maintained in the Office of the Chairman of the Government Patents Board, to make information concerning Government-owned inventions more widely and conveniently available and more useful to American business.

The titles of the other six books are *Chemical Products and Processes* (1349 abstracted inventions); *Food Products and Processes* (265 abstracted inventions); *Metal Products and Processes; Machinery and Transportation Equipment* (658 abstracted inventions); *Electrical Apparatus*, including *Electronics* (1920 abstracted inventions); *Ceramic, Paper, Rubber, Textile, Wood, and Other Products and Processes* (308 abstracted inventions); and *Ordnance* (647 abstracted inventions).

The new book *Instrumentation* (Order No. 111464), may be purchased at $2.00 a copy from the Office of Technical Services, United States Department of Commerce, Washington 25, D. C. (Room 6227, Commerce Building).

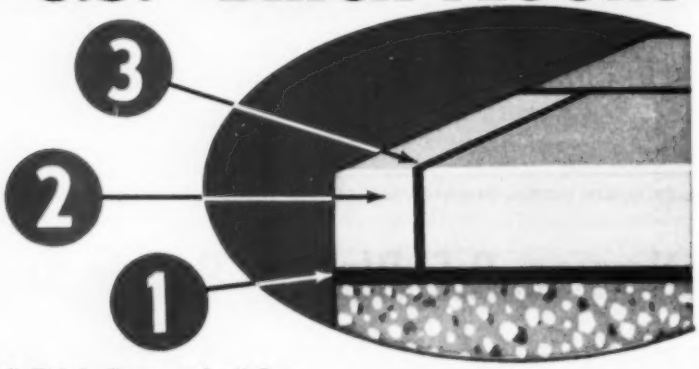
**L—917. Rubber-Covered Factory Doors**—The new rubber-covered Dura-Dor, a heavy-duty factory door designed to withstand the pounding, bumping wear of industrial lift trucks passing through is illustrated and described in a new bulletin of American Hard Rubber Company, New York. Dura-Dor is rigid, strong, lightweight plywood, reinforced with sheet steel and completely covered with a tough hide of rubber. The door is corrosion-resistant, excellent for chemical plants where corrosive fumes or splashing liquids are a problem. It eliminates the need for expensive door-opening devices and bumpers, saves heat, and adds to worker comfort. For your copy of the bulletin, use Reader Service Card.

**L—918. New Edition of Handbook of Chemistry and Physics**—The 35th edition of the *Handbook of Chemistry and Physics*, published by the Chemical Rubber Company, Cleveland, is now available.

A great deal of new and revised material has been assembled in this concise volume, which is indexed for easy reference.

The publisher is featuring the deluxe 35th edition, which is produced with the finest quality India paper, normally used in expensive dictionaries or bibles. This edition contains the same number of pages as the regular edition, but the use of India paper reduces bulk, thus assuring a more compact, usable book. For details regarding the purchase of this reference book, use Reader Service Card.


**Low Initial Cost — Negligible Maintenance**
**Protection Against *BOTH* Acids and Alkalies**
**in "U.S." BRICK FLOORS**




A "U. S. Triple Construction" Corrosion Resistant Brick Floor provides complete protection against acid and alkali attack for practically an unlimited number of years — usually without maintenance expense of any kind.

First, an impermeable membrane of U. S. Stoneware's "RESILON" is applied over a 4" to 6" rigid sub-base. Chemically-resistant, nonporous, and flexible, Resilon protects the subfloor against acid seepage. Then split or full size "USSCO" Acid Brick (depending on the load) are buttered with "DURISITE" Cement and laid with joints $\frac{1}{16}$" to $\frac{1}{8}$" thick.

"USSCO" Acid Brick are dense, strong, resistant to erosion and spalling. Accurately shaped to lay tight and flat. "DURISITE" Cement sets quickly by chemical action — resists *both* acids and alkalies, as well as oils, greases, solvents and water. Completely nonporous, it bonds brick tightly with wafer-thin joints. Durisite is nontoxic, safe for workmen to use, and stable in storage.

**YOUR OWN MASONS CAN LAY A "U.S. TRIPLE CONSTRUCTION" FLOOR**

We will provide the materials for your own workmen to install a "U. S. Triple Construction" Floor, or if you prefer, we can handle the installation of the complete floor.

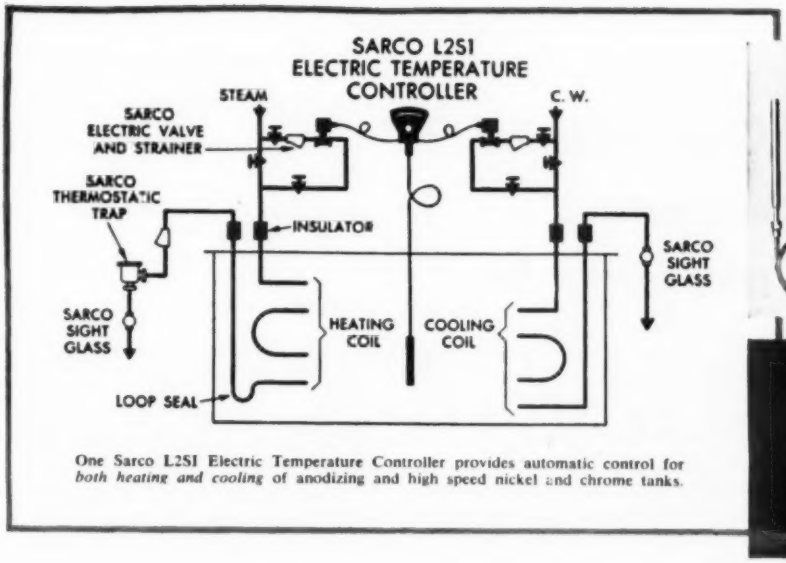
**Write for this free book!**

*Detailed construction drawings showing approved methods of building floors, trenches, gutters, tank and motor supports, etc., with full technical data, photographs and case histories. Ask for Bulletin AB-17.*

413C

U. S. STONEWARE
AKRON 9, OHIO

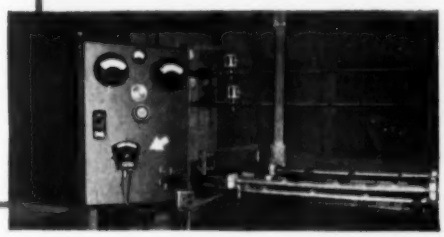
PROCESS EQUIPMENT DIVISION




One Sarco L2SI Electric Temperature Controller provides automatic control for *both heating and cooling* of anodizing and high speed nickel and chrome tanks.

Sarco Electric Temperature Controllers hold baths to within plus-minus 1°F. Temperature setting is easily changed by turning only one knob.

Brunswick Radio Corp., Chicago, enjoys all the benefits of automatic temperature control in its chromium plating operation with a Sarco Electric Temperature Controller.



# It costs less than you think to install Sarco Electric Temperature Controls

## . . . and you profit 4 ways!

Some platers believe that automatic temperature controls are expensive. Actually, Sarco automatic controls can be bought for as little as $130 a tank . . . *and often pay for themselves in just weeks!*

### Here's How

Platers know that uneven bath temperature is one of the major causes of rejects and poor product quality. Many of them also know that a good deal of steam is wasted by manual attempts to keep temperatures where they belong. Furthermore, time lost in making these temperature adjustments with hand valves can be used more profitably in serving additional tanks.

With Sarco automatic controls desired temperatures are adjusted quickly by turning *one* knob and once adjusted stay where you want them . . . automatically. You profit 4 ways because:

**You improve product quality**

**You lower rejects**

**You save man-hours**

**You save steam and solutions**

Call in the nearby Sarco representative and have him show you just how little it costs to get all these benefits. For complete information on the advantages of Sarco plating controls, write for Technical Bulletin No. 6.

**Some of the Many Companies Relying on Sarco Electric Temperature Controls**

Bendix Aviation Corp.
Consolidated Razor Blade Co.
General Electric Co.
Howard Plating Industries, Inc.
Mergenthaler Linotype Co.
Pontiac Engraving & Electrotype Co.
Ronson Art Metal Works
Schick, Inc.
Southern Gravure Service, Inc.
The Upjohn Co.
U.S. Electric Mfg. Co.
United States Steel Corp.
Western Electric Co.
Westinghouse Electric Corp.

# SARCO SAVES STEAM

**SARCO COMPANY, INC., Empire State Building, New York 1, N. Y.**
Sarco Canada, Ltd., Toronto 8, Ontario . . . Represented in Principal Cities

TEMPERATURE CONTROLLERS • STEAM TRAPS • STRAINERS

Self-operated Cooling Controls | Electric Valves (solenoid) | Strainers | Dial Thermometers | Degreaser Vapor Line & Safety Controls | Float-Thermostatic Steam Traps | Thermostatic Steam Traps | Thermaton | Self-Operated Temp. Reg



FOR FURTHER INFORMATION, USE READER SERVICE CARD: INDICATE A 1127.

Check corrosion and extend tank service life

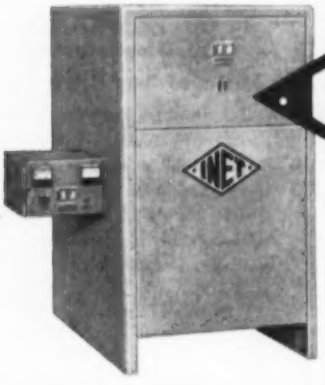
with LEAD LININGS by STORTS

Every seam, every connection in Storts-welded lead linings is thoroughly bonded with extra heavy welds that guarantee full corrosion protection and long life utility value. For all of your lead work you can depend on Storts for dimensional accuracy, sound, strong welds and complete satisfaction.

42 STONE STREET — STORTS WELDING COMPANY INCORPORATED — MERIDEN, CONN.

*Manufacturers of Welded Fabrications to Specification*

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 1128.



INET Regulated

DC POWER

FOR ELECTROPLATING and ANODIZING

- FULLY AUTOMATIC
- LOW COST
- ALL STATIC COMPONENTS

**CHARACTERISTICS**

**AC INPUT:** Three phase — 208, 230, 460, ± 10%

**DC OUTPUT:** Plating Rectifiers — 1,000 to 10,000 Amps. 6, 9, 12 volts

Anodizing Rectifiers — 500 to 5,000 Amps. 42 volts

**REGULATION:** All units ± 1% no load to full load.

Providing the finest Voltage and Current regulation, these DC Plating units combine the long-life efficiency of selenium rectifiers with the *proven dependability* of magnetic amplifiers. Completely automatic, they require no attendance during the entire plating or anodizing cycle, and will give years of maintenance-free operation.

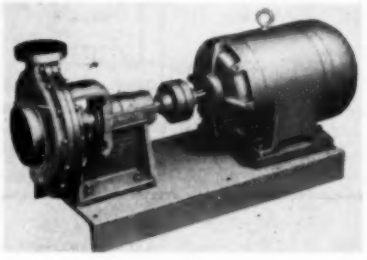
Advantages are low initial cost, low maintenance cost, reduced power bills, efficient cooling, quiet operation and easy installation. Available are plating power supplies for all electrolytic processes, particularly where closely controlled voltage or current is essential.

*Literature and engineering specifications available on complete line of DC Plating Units.*

INET DIVISION OF LEACH CORPORATION
4441 Santa Fe Avenue, Los Angeles 58, Calif.
Phone LOgan 8-4771


# Equipment and Supplies

**E—919. An Improved Line of Vulcanized Rubber Lined Centrifugal Pumps**—Industrial Filter & Pump Manufacturing Company, Chicago, announces an improved line of vulcanized rubber lined centrifugal pumps. These pumps are de-



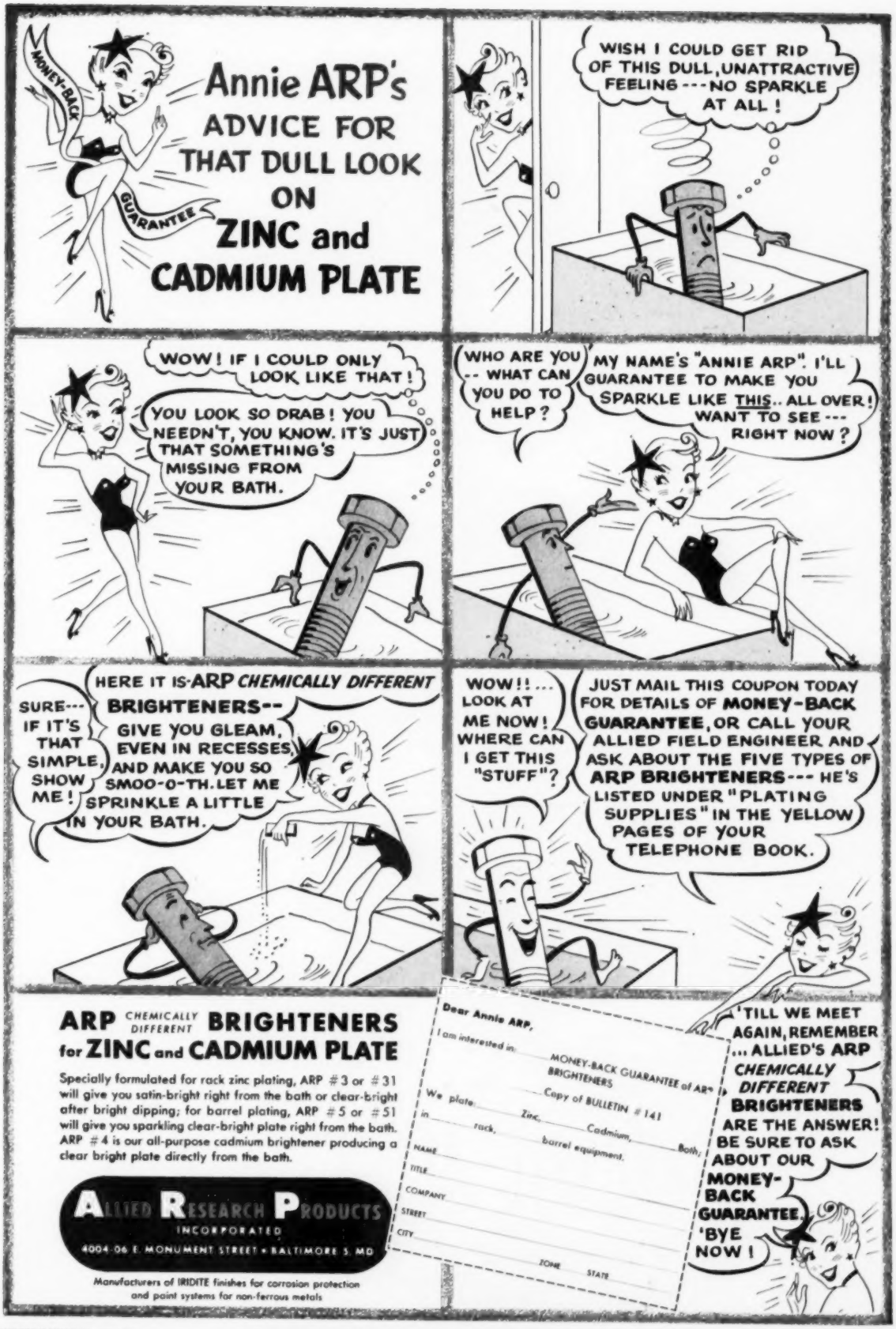
signed especially for severe, continuous service in handling corrosive and non-corrosive liquids in refineries, chemical processing and food plants, and metal finishing departments. Lined with soft rubber for abrasive slurries or hard rubber as specified, balanced rotating assembly mounted in ball bearings, corrosion-proof stuffing box to permit external liquid seal if required, easily removable packing gland nut and ample space for repacking stuffing box, simple adjustment of impeller clearance are some of the construction features.

These pumps are available in a range of sizes with capacities up to 240 gpm, operating heads of 240 feet and ¾ to 15 hp. They are furnished either with or without base, motor, and coupling. For more information, use Reader Service Card.

**E—920. New Finishing Product**—The first research product to come from the laboratory of Kosmos Electro-Finishing Research, Inc., Belleville, N. J., is Ker-Chro-Mite-1. By simple immersion, Ker-Chro-Mite-1 brightens and passivates both zinc and cadmium and protects surfaces from finger staining and normal atmospheric oxidation. Ker-Chro-Mite-1, it is claimed, produces a brilliant blue-chrom finish with only a hot water leach or a mirror-bright finish with a mild alkali leach.

The new product needs hardly any control since at room temperature or only mildly heated consistent reproduceable results are obtained. For further details, use Reader Service Card.

**E—921. New Anode Hooks.** The Heil Process Equipment Corp. of Cleveland has recently announced additions of two standard hooks for their complete line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Specially formulated for rack zinc plating, ARP #3 or #31 will give you satin-bright right from the bath or clear-bright after bright dipping; for barrel plating, ARP #5 or #51 will give you sparkling clear-bright plate right from the bath. ARP #4 is our all-purpose cadmium brightener producing a clear bright plate directly from the bath.
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## *Equipment and Supplies*

of lead anodes used in chromium plating operations.

These hooks are designated as #12 and #12A, and both are heavier than any previous anode hook offered to the electroplating trade. These hooks will be used only on the popular Super-X and Super-XX style lead anode. Both hooks are $\frac{3}{8}$ x 2 inches in cross section and are principally designed for use with rectangular bus bars, but can also be used with round bus bars. For further information, use Reader Service Card.

**E—922. Improved Carbon Pile Rheostat**—An improved carbon pile rheostat has been announced by Hanson-Van Winkle-Munning Company, Matawan, N. J. Built on a unique principle of construction, the H-VW-M rheostats are considerably more compact than conventional carbon pile rheostats and generally perform better, especially at high amperages.

Designed for use in electroplating installations, the new rheostats may be used in any low-voltage, high-current application where stepless control is desired. This would include, among other things, general testing work.

Unlike the conventional multiple-tube carbon pile rheostats, the H-VW-M rheostats are built of rectangular carbon plates formed in a single pile and housed in a one-piece steel box. They are rated from 25 to 250 amps on continuous service, with higher ratings when loads are intermittent. Resistance changes range as high as 50 to 1. For further information, use Reader Service Card.

**E—923. A New Automatic Selenium Rectifier**—A new automatic selenium rectifier for heavy-duty production testing has been announced by Richardson-Allen Corp., College Point, N. Y., and is reported to have an adjustable output voltage ranging from 3 to 15 volts, 25 to 120 amperes d-c, filtered to 1 per cent rms ripple, with automatic constant voltage plus or minus 1 per cent. There is also automatic correction of plus or minus 5 per cent for fluctuations of the a-c input, which is 220 volts, 3-phase, 60 cycles. The unit is convection-cooled for 35° C ambient temperature operation and offers the advantage of automatic circuits which are completely magnetic, with no electronic components. For additional information, use Reader Service Card.

**E—924. Strippable Masking Material**—Better Finishes and Coatings, Inc., Newark, N. J., has developed a masking material that is said to be freely strippable after baking at 400° F for 15 minutes.

This strip coating is adapted to finishing operations where it is necessary to mask off certain areas prior to applying baking enamels. The manufacturer recommends spray or brush applications to produce a film thickness of approximately 4 mils. Technical data and samples may be obtained by using Reader Service Card.

**E—925. Nonetching Aluminum Cleaner**—Enthone, Inc., New Haven, Conn., has announced the development of a new detergent for rapid cleaning of aluminum. This product is called "Aluminum Cleaner NE 6." It is stated to be mild in alkalinity, does not etch metals either at the air interface or in contact with other metals, and at the same time possesses very high detergency. It is


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claimed to have remarkable ability to disperse oils and to remove marking ink and crayon normally present on aluminum sheet. The cleaner is recommended for cleaning cast and wrought aluminum prior to anodizing, chromate treatment, organic finishing, resistance welding, and plating by the nonetching process. For further information, use Reader Service Card.

**E—926. New Insulating Bushing on Daniels Barrels**—A new nylon insulating drive shaft bushing now is being installed as standard for all new type OLS Daniels plating barrels, according to the manufacturers, Daniels Plating Barrel & Supply Co., Newark, N. J.

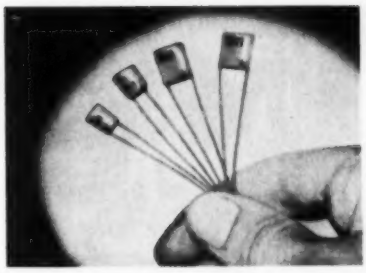
This insulating bushing provides a strong wearing surface for the drive gear and completely insulates the driving assembly. Its outstanding advantage is that it permits all the d-c power to go directly to the plating parts and reduces the possibility of stray currents. Also, it reduces gear wear since it eliminates arcing through gears, which previously has caused excessive wear. For more information, use Reader Service Card.

**E—927. Alkaline Derusters**—Oakite Products, Inc., manufacturers of specialized cleaning and allied materials, have announced the development of Oakite Rustripper, designed for alkaline derusting of precision parts where dimensional change and acid embrittlement must be avoided. In addition to removing rust and heat scale from ferrous metals, this material also has proved effective in certain cases for descaling heat-treated titanium in aircraft plants.

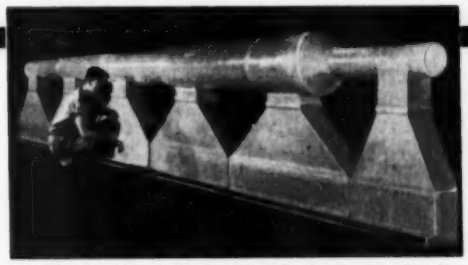
Oakite Rustripper, the manufacturers state, is a heavy-duty, off-white powder that may be used in hot or cold solutions. It may be used also with direct current to remove deep-pitted rust, or reverse current to remove heat scale. Among the advantages claimed for this material are: it will not attack sound metal; it will not cause hydrogen embrittlement; it does not require special equipment, such as stainless steel tanks; it creates no troublesome fumes; it may be disposed of in the same manner as any highly alkaline solution; it strips certain types of paint at the same time as it removes rust; and it protects against rerusting. For further information, use Reader Service Card.

**E—928. New Subminiature Selenium Diodes**—Four new selenium diodes have been developed for addition to the line of subminiature selenium diodes in production at International Rectifier Corporation, El Segundo, California. The new additions are rated for a maximum a-c input voltage of 52 v to 130 v and for maximum d-c output voltage of 60 v to 80 v. They will deliver an output current of 5 ma to 11 ma. Each diode is completely encapsulated within a thermosetting plastic and may be operated in an ambient temperature range of −50° C to 100° C.

Applications for these selenium diodes include their use to provide bias for tubes



in military and commercial electronic equipment. Currently, the company is sponsoring a unique contest to promote additional applications for these units. A new Ford, plus 19 additional valuable prizes, will be awarded to the winning entries. Complete information on selenium diodes and details about this contest and official entry blanks are available by using Reader Service Card.

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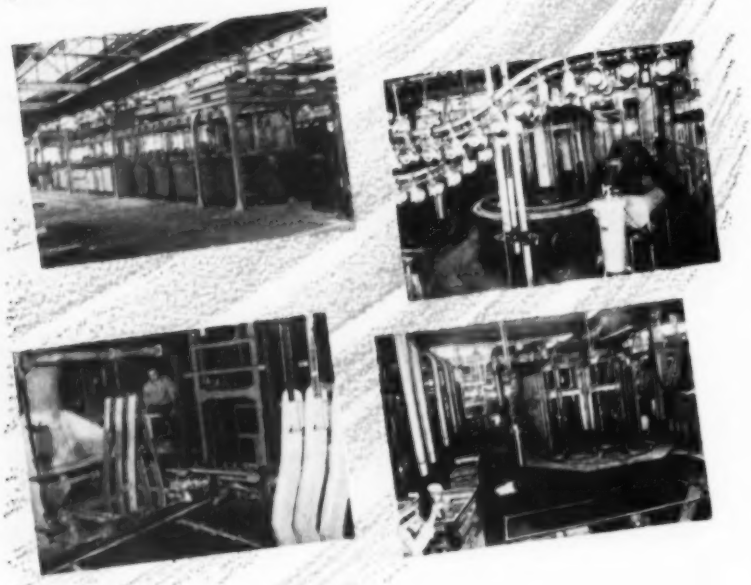

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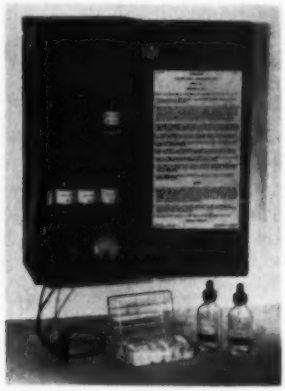
**E—929. Plating Indentification Kit**—The Kocour indentification set model PIA is used to identify and differentiate between metallic deposits. Tests are provided for identifying cadmium, tin, silver,



lead, nickel, chromium, and zinc and the presence or absence of chromate conversion coatings. The set is complete and includes all of the necessary solutions in stopper and dropper bottles, contact papers, and a panel with meter, on-off switch, batteries, and leads with probe and clip, all enclosed in a wall-type wooden cabinet.

The cadmium identification set is also available for those interested in differentiating between cadmium and zinc only. This economical set is packed in a handy two-tray box. For additional information, use Reader Service Card.

**E—930. Improved Brightener**—A 30 to 100 per cent increase in the corrosion resistance of barrel nickel plated steel parts was recently shown in a series of tests of a newly improved formula of Nickelite brightener. The tests were conducted under standard salt-fog conditions by the manufacturer of the brightening agent, Platers Research Corporation of New York.

Comparison of parts plated in solutions resulted in improved corrosion resistance of 30 per cent for minimum deposits of nickel and up to 100 per cent for thicker deposits. Coupled with this improvement, according to the manufacturer, is the elimination of the usual brittleness of nickel finishes and an accompanying attainment of maximum brilliance of the surface. For further information, use Reader Service Card.

**E—931. Surface Roughness Scales**—New cylindrical surface roughness scales, designed as a standard of comparison by sight and touch for internal and external curved surfaces, have been developed by the General Electric Company's Instrument Department.

Consisting of two scales each, six inches wide and two inches long, the set is used for determining the roughness of surfaces produced by grinding, lapping, honing,

superfinishing, turning, boring, and drilling, according to G-E engineers.

Scale No. 1 is capable of determining the surface roughness of 10 specific surfaces, an example of which would be that produced by grinding, lapping, or honing and super-finishing in the 4, 8, 16, 32, and 63 microinch categories. Surfaces on this scale are both external and internal.

On scale No. 2, typical surfaces, such as those produced by lathe and screw-machine operations in the 16, 32, 63, and 250 microinch values, are represented by turned as well as bored surfaces.

The new surface roughness scales provide a standard objective reference by which engineers and draftsmen can designate the roughness and appearance of numerous finishes required for functional purposes. For further information, use Reader Service Card.

**E—932. New Style Corrosion-Resistant Heater**—The new HN Style "Nocordal" immersion heating unit compliments the other popular types of impervious graphite heating and cooling coils and external exchangers produced by Heil Process Equipment Corporation, Cleveland.

This HN Nocordal heater is designed specifically for use in services involving nitric acid. A plastic coated steel hanger is included to assure proper location of the HN heater in the tank. The normal excellent suitability of Nocordal products for muriatic, sulfuric, hydrofluoric acid, and other acid and salt solutions is maintained fully in the HN style units. The excellent heat transfer properties of Nocordal provides greater heating or cooling per square foot of surface area than obtained through the use of most metals. For more information about the new HN unit or other Nocordal products, use Reader Service Card.

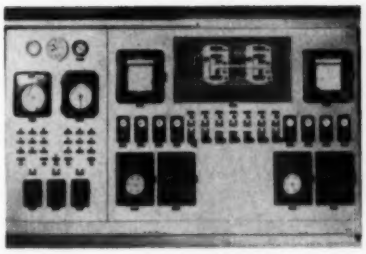
**E—933. Epon Resin-Type Coating Stripper**—Northwest Chemical Company, Detroit, Michigan, has announced a new compound designed specifically to remove a wide variety of Epon Resin base coatings. The compound, called Liquid Stripper No. 9, will strip Epon finishes from both ferrous and nonferrous metals at temperatures ranging from room to 190° F at time cycles from two minutes to two hours.

With the exception of aluminum, which it will etch, Liquid Stripper No. 9 will not attack the base metal. It is noncorrosive, thus allowing its use in plain steel tanks.

Northwest will gladly process Epon finished parts, whether clear or pigmented, single or multiple coated, air dried or baked, to show the effectiveness of the new stripper. For details, use Reader Service Card.

**E—934. Graphic Panel for Automatic Ion Exchange Equipment**—Graver Water Conditioning Company of New York has available a graphic panel arrangement for all automatic ion exchange equipment that allows the operator to see at a glance if the system is functioning properly.

On the graphic panel control board is located, in addition to the usual controls, meters, and recorders, a pictorial representation of the ion exchange units and the immediate piping and valves. Each valve representation has two colored lights—one red and one green. When the operation valve is open, the green light is on; when the valve is closed, the red light is on.



All pipe lines are also lighted and colored. There is a different color for each material being carried, such as acid,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caustic, inlet water, and outlet water. In cases where a line carries two different materials, a different color or pictorial arrangement is used to indicate this also.

There is a printed legend on the panel so that the operator can very easily determine if the system is functioning properly and, if not, just where the problem lies. For further information, use Reader Service Card.

**E—935. Vinyl Coating for Paint Spray Booths**—Successful development of a white-pigmented vinyl coating for paint spray booths—designed to aid the user to obtain a better finished product at substantially lower costs—has been announced by the Detrex Corporation of Detroit.

Called White Vincote, the material is sprayed on wall surfaces of spray booths. Drying almost at once to a tough, white film, it permits paint, lacquer, and enamel overspray to be peeled off quickly and easily. For further information, use Reader Service Card.

**E—936. Used Machinery Exchange**—A new service by which idle metal treating equipment can be exchanged for needed items or batch machines can be replaced with modern continuous ones has been announced by the Metal Treating Equipment Exchange of Detroit. Full details may be obtained by using Reader Service Card.

**E—937. Polyethylene Packaged Cleaners**—Announcement that two top-quality steam cleaning materials and a quick and effective concrete floor cleaning compound are now available in polyethylene-protected, heat-sealed waterproof 5 pound packages recently was made by Turco Products, Inc., Los Angeles, Calif.

The products offered in the new Turco package are Super Steamfas, a heavy-duty steam cleaning compound; Super Steameze, a light-to-medium-duty steam cleaning material for all around all-purpose use; and Oilift, a nonhazardous, easy-to-use material for bleaching and removing grease and oil from concrete floors.

The new Turco 5 pound packages are packed ten to a case for easier handling and storage. All packages and cases are color coded for quick and easy identification. For more information, use Reader Service Card.

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# SOME CONSIDERATIONS OF IMPORTANCE IN BALL BURNISHING*

ARTHUR S. KOHLER†

While ball burnishing in tumbling barrels has been practiced for many years, little material has been published that considers the basic problems involved in obtaining a brilliant metallic finish in barrel burnishing operations. Some operators secure fine results, others are less successful, and many results are found to vary between batches, even in the same barrel and with what is supposed to be the same stock of metal parts.

The purpose of this paper is to discuss various factors which are of material importance in determining the final quality of the work. It is hoped that some of the points discussed here will give the operator a better understanding of the problems involved and produce a general improvement in the results obtained.

In barrel tumbling, there are numerous tumbling media and types of compounds used; but in general, there are only three basic actions that can take place, as far as the tumbled metal parts are concerned, namely: (1) the metal may be worn away gradually by a grinding action of abrasive, (2) with a brittle metal (such as hardened steel) sharp edge burrs may be broken off, or (3) the metal surface crystals can be deformed or caused to flow due to pressure against the surface exerted by contact with the rolling medium or other work pieces in the barrel. While there is a general similarity between deburring and burnishing, there is also a sharp distinction between the two operations, since deburring employs grinding action, metal flowing, and sometimes chipping, whereas the only action in ball burnishing is metal flow.

Before the problems involved in the burnishing barrel are considered, a brief discussion of the properties of metal will be quite helpful. Metals vary considerably, and each metal may be said to have its own personality. Metals vary in color, melting point, hardness, density, corrosion resistance, and malleability. Furthermore, when fabricated parts are dealt with differences are found in size, shape, thickness, weight, and surface conditions in general.

All metals are composed of crystals, of either large or small size, and in many there may be two or more types of crystals present in the same alloy. In a rough way, metals may be divided into two classes: those whose crystals are easily deformed, for example, copper or lead; and those whose crystals are set in a fairly rigid state, such as hardened steel. When the gentle pressure of a hard surface is brought to bear on a piece of metal, the metal bends slightly. When the pressure is released, the metal returns to its original shape. The reason for this is that the metal has a certain amount of *elasticity*. As long as the pressure applied to the metal is less than a certain amount (which differs for each metal) the same action occurs. Now if the pressure applied to the surface exceeds the amount mentioned above, it is found, upon release of the pressure, that the metal no longer returns to its original shape but has become deformed permanently. This ability of a metal crystal to deform under pressure without having the metal break is called malleability. The degree of malleability varies enormously between metals; such metals as copper, soft brass, and pure aluminum are quite malleable. Hardened steel has, however, practically no malleability and will rupture rather than bend when the elastic limit is exceeded.

When the metal is deformed due to physical changes in the metal crystals themselves there is a tendency for the crystals to interlock more rigidly and become less malleable. The metal is now said to be *work hardened*. As the amount of deformation increases the harder the metal becomes, the more difficult it is to deform it further. If one wishes to deform the metal further, it is necessary to heat it to a high temperature. The various internal strains are relieved and the metal returns to approximately its original malleability. The metal is now said to be in the *annealed* condition and can be worked again.

In addition to the physical properties mentioned above, one needs to consider the state of the surface itself since this is where the burnishing action takes place. Initial surface conditions of a metal vary enormously and range from a rough matte to a mirror-

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, July 12, 1954.
†Technical Director, Frederick Gumm Chemical Company, Inc.

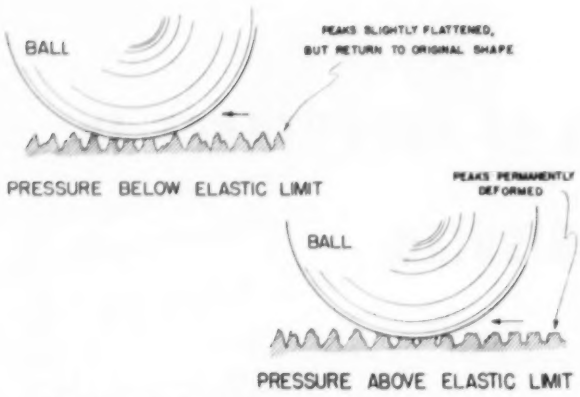


*Fig. 1. Action of burnishing ball on high points of the work*

like polish. A matte surface is dull because it consists of numerous hills and valleys, or grooves and ridges. The problem in ball burnishing is to push down these hills and produce a smooth brilliant surface. In a sense, what a road-roller does on a large scale, the burnishing balls do on a microscopically small scale. The burnishing medium is applied against the surface under pressure until the surface crystals are deformed to the desired extent. Since surface roughness varies enormously in a microscopic way, it is reasonable to suppose that if two pieces of the same metal with different amounts of roughness are both burnished, the one with the lesser roughness will be easier to smooth.

In order to flatten the hills, it is necessary to apply a force on the burnishing ball which is sufficiently high enough to exceed the elastic limit of the metal crystals (Fig. 1). It would be perfectly possible to allow a single small burnishing ball to roll over a surface for an indefinite time and have no noticeable change produced in the apparent surface roughness. However, when sufficient pressure is applied, for example, by pressing against the ball with a flat board, and rolling it over the surface, it will be found that the path of the ball shows up as a bright line on an otherwise matte surface. Here the elastic limit of the surface crystals has been exceeded, and they have been deformed permanently; some of the hills have been pushed down, and the surface made more even. While these hills have been pushed down, the surface crystals of the parts have been work-hardened and as a result further burnishing is much more difficult. When the burnishing is continued for a sufficiently long time, either the surface becomes smooth and polished in appearance, or it becomes so work-hardened that further burnishing is impossible. At this point, if the surface is not sufficiently burnished, one has a choice of applying more pressure; for example, by using a larger and a heavier load, or the parts could conceivably be annealed and reburnished. Neither of these methods is practical. Here is where the previous treatment of the work is of importance. This is somewhat like the rule for being very tall—the surest way is to pick one's self tall ancestors.

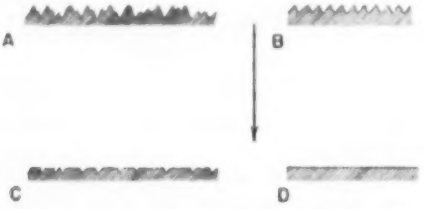


*Fig. 2. Type of surfaces obtained by burnishing (diagramatic)*

*A, Coarse surface before burnishing*
*B, Smoother surface before burnishing*
*C, A after burnishing*
*D, B after burnishing and work hardening*

In the consideration of two surfaces in cross section (Fig. 2), it is seen that A is coarse and B is fine. After these surfaces have been burnished for a given time, A appears like C, and B appears like D. The burnishing barrel has done the same amount of pressing and pounding on both pieces, but A had much further to go and had work-hardened to the point where further burnishing is a waste of time. In most cases, if a surface cannot be burnished within a few hours, the surface has not been prepared properly. Also, barrel operations are similar to wheel finishing. Thus, when a rough casting is to be wheel finished to a high polish, one does not start with a fine polishing rouge and expect a smooth uniform brilliance in a short time. On the contrary, one progresses from a coarse cutting wheel to finer wheels and compositions and finally to a coloring operation. In barrel operations, the deburring barrel does the rough cutting and brings the surface to the proper degree of smoothness so that burnishing produces the smooth, brilliant luster desired.

*Point 1*—the surface of the metal should be in a proper state of smoothness before burnishing.

In connection with surface roughness, the question of the malleability of the metal is also of importance. It is possible to finish two metals, for example, brass and hardened steel to the same degree of surface roughness. However, when both pieces are put in the same barrel and burnished for the same length of time, the brass develops a brilliant smooth finish whereas the hardened steel is still matte and lifeless in appearance. The reason for this difference is that the brass is fairly malleable and the surface crystals are able to flow readily under the conditions of pressure developed in the barrel, whereas the steel has a rigid structure which is only very slightly malleable. In the case of hardened steel, the surface finish has to be in the neighborhood of a few microinches before any appreciable burnishing can be obtained. With mild steel, a rougher surface is permissible and so on as the metal increases in malleability.

*Point 2*—The harder or less malleable the metal the finer the surface should be before burnishing.

*Fig. 3. Differences in finishes. Left, brilliant mirror-like reflection Right, flat reflection lacking "depth of color"*

*Fig. 4. Illustrating the use of a tube for shielding reflection from stray light*

A frequent source of disappointment in barrel burnishing is lack of depth of color. For example, two pieces of brass are deburred in different ways and brought to the same degree of light matte finish. Both are barrel burnished in the same barrel for the same length of time, yet one comes from the barrel with a brilliant mirror-like appearance, and the other, while just as smooth and shiny, has a flat lifeless appearance. The second piece lacks "depth of color." If one looks at the reflection of his eye in the two pieces, he will find a clear distinct reflection in one case, and in the "flat" piece, he will see only a hazy indistinct reflection (Fig. 3). If a blackened cylinder is rested against the surface of the "flat" piece (Fig. 4) and one again looks at the reflection of his eye, it will be found that he now sees a clear distinct reflection similar to Fig. 3A.

Why is there such a difference in the reflection when the cylinder is used from what is seen when no shield is employed? The reason is that the surface with poor depth of color is covered with numerous fine holes whose surfaces are not parallel to the surface of the plate. As a result, side light is picked up by these pits and part of it is reflected to the eye. This mixture of reflections produces a fogged appearance. Fig. 5 will help to make this point clear.

The eye looks perpendicularly at the surface and sees its reflected image. However, stray light from the side hits the tiny surface pits and is scattered in all directions. Part of the scattered light reaches the eye and the general effect is a fogging of the image. When the black cylinder is inserted between the eye and the plate the side light is cut off and the only light being returned to the eye is the clear reflected image.

Actually, the surfaces of the two pieces A and B were as shown in Fig. 2, B burnished to the surface like D and A burnished to a surface like C to produce a flat finish. While probably 90 to 95 per cent of the surface area of C is perfectly smooth and mirror-like, the 5 or 10 per cent pitted area produces the fogged reflection and lacks "depth of color."

*Point 3*—To obtain good "depth of color" the surface should have a fine matte surface and be free of pits before the burnishing operation.

Up to this point, we have assumed that the surface of the metal is perfectly clean and free of all impurities. In practice, this is never the case since all fabricated metal has an oxide coating (however thin it may be), and in addition, may be coated with oil and shop dirt. Most oxides of metals are relatively hard and often are somewhat abrasive in character. Furthermore, these oxides usually are not metallic in appearance but have various colors. These oxides generally are not removed by barrel burnishing but adhere to the surface and give the work an off-shade color. Oil and dirt tend to stick to the surface or be pounded into microscopic pores and again cause discoloration. In practically all cases, a two-step cleaning cycle should precede ball burnishing. First, the parts should be soak-cleaned or tumble-cleaned with alkaline cleaners to remove all dirt and oil. Then, after rinsing, the parts should be given a light descaling or pickling operation. Usually, such a treatment removes surface oxides and gives the surface a very clean light matte finish. For burnishing, such a finish is to be preferred to a smoother surface, since the tiny hills are of microscopic size and are pressed down easily by the burnishing balls, and fresh-clean bright metal rapidly is exposed to view.

*Point 4*—Remove all oil, dirt, and scale from the surface before burnishing.

In the case of work which has been barrel deburred, there is a good likelihood that there will be a certain amount of abrasive impregnated in the surface of the work. If even a small amount of abrasive finds its

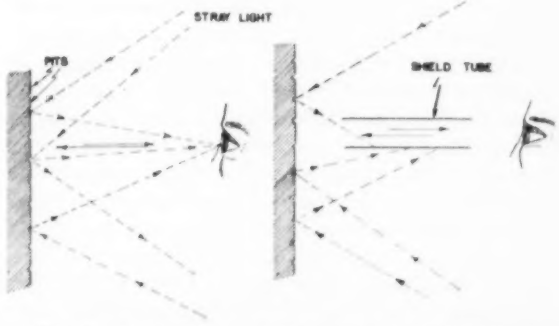


*Fig. 5. Explanation of function of tube in Fig. 4 reason for flat, lifeless finishes*

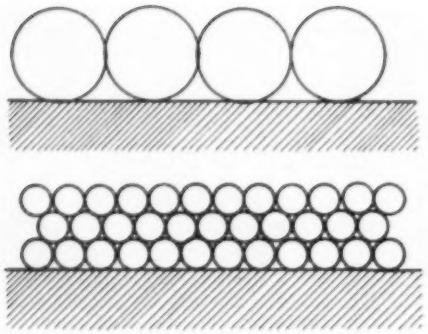

*Fig. 6. Variation in the number of points of contact with the size of the media*

way into the burnishing barrel, there will be trouble, and the work will be dark in color. As was said before, ball burnishing is concerned only with the flow of surface crystals. As soon as there is abrasive in the barrel there will be some grinding action produced. This may roughen the balls slightly, and they will then act like fine files and will further grind the work. Such grinding action produces some fine metal particles which appear blackish in color. Some of these particles are pushed into the surface of the work and tend to give the black color sometimes obtained in burnishing.

*Point 5*—Remove all abrasive from previous cutting-down operations, since any abrasive carry-over to the burnishing barrel will cause dulling and discoloration.

Let us now consider the medium. For most burnishing, highly-polished, case-hardened balls are preferred, although at times diagonals, cones, and pins are used for special jobs. In the light of the previous discussion, certain points will be readily apparent. In order to accomplish any burnishing, it is necessary to apply a pressure against the surface greater than the elastic limit of the metal crystals at the surface, and the greater the pressure the more the surface will be deformed, and the hills will be leveled with the valleys. The pressure on the surface is due to the weight of the load above, pressing the steel balls into the surface of the work. Consider a flat surface in a tumbling barrel. The total pressure per unit area of work depends on the weight of shot above the balls. Fig. 6 shows two examples, in case A, large burnishing balls are used and in B, small ones. Both A and B are the same length but where there are 4 points of contact on A per unit length, on B, there are 12. Or per unit *area*, there would be 16 points of contact and 144, respectively. If the total weight above is the same in both cases, each point of contact in case A will carry 144/16 or 9 times as much pressure as in case B. As a result, the burnishing action in A is much greater and the time required much less than for B. In practice, it is found that the larger size medium is much more effective than the small sizes. However, another problem enters at this point. Unfortunately, the larger sized shot, while more rapid in action, tends to damage the work much more than small shot.

There are two principal reasons for the damaging of work by large medium. The larger medium with high pressure at points of contact acts not only on the surface crystals, but also, due to excessive pressure, works on *subsurface crystals* and distorts the surface to a greater depth. This type of heavy action produces "ball pattern" or "orange-peel" effects. The second drawback to large sized shot is the *lack of fluidity* of the mass when large size medium is used. In a rough qualitative way, this matter of fluidity can be shown by considering three containers loaded with steel balls. In one, let us say, we have $\frac{1}{8}$-inch balls, in the second, $\frac{1}{4}$-inch balls, and in the last, $\frac{3}{8}$-inch balls. If a stick is pushed into each pail in succession, it will be found that the stick can be thrust into the $\frac{1}{8}$-inch shot to quite a depth with little effort, with the $\frac{1}{4}$-inch considerably more effort is required to move the stick even part way into the load, and in the case of the $\frac{3}{8}$-inch shot, it will be found that the stick can be pushed only a little way even with considerable effort. In other words, the large sized shot constitutes a mass, which is relatively rigid in character, whereas the small shot acts more like a fluid. In the tumbling barrel, Fig. 7, we find that the main mass of material is moving as a solid mass (to a large extent) and rotates with the barrel until it reaches the point where it starts to slide cross-wise of the barrel and down hill. Parts which project from the mass, "A" (Fig. 7), moving with the barrel into the landslide zone are struck by the down-flowing work and medium. If the shot is large, the parts projecting into the landslide are held in a rigid position and these parts receive the full impact of the down-sliding shot and work. Furthermore, the energy with which large balls strike the work will be much greater with each collision than would be the case with smaller shot. In the case of the smaller shot, due to the more fluid character, the projecting part, "A" (Fig. 7), will be able to cushion the shocks and shift its position so as to protect itself.

The hardness of the work being burnished also should be considered here, since in practice harder metals can be burnished better with larger shot than would be the case with soft metals. The writer finds that for most soft metals a 5/32 inch ball is quite satisfactory. Where diagonals and cones are required, it is preferable to use the smaller sizes whenever possible, and usually a better job is obtained if a mixture of balls and diagonals (or cones) is used rather than the diagonals only. Diagonals, due to their sharp edges, are inclined to cause a choppy, orange-peel type of surface.

*Point 6*—Use as large a shot as possible without damaging the work.

Before leaving the subject of burnishing shot, it is well to consider the condition of the shot itself. Burnishing balls should be sparkling clean and look like drops of quick-silver at all times. If the shot becomes rusty, rough, or dirty, a clean brilliant color cannot be obtained on the work. If the shot is merely dirty, it can be cleaned by tumbling it several times with a good grade of burnishing compound and thoroughly rinsing

the barrel each time. Sometimes the addition of a little alkaline cleaner to the burnishing compound will be found helpful. If the shot is moderately rough or rusted, then the best thing is to recondition the surface entirely. Polishing compounds are available which will bring back a sparkling surface to the shot in a 12–24 hour tumbling time. After the polishing, the barrel must be rinsed thoroughly and the balls tumbled with several charges of burnishing compound before being put back into service. Dirty shot rubs some of the dirt onto the surface of the work and spoils its brilliance. Dull shot has sufficient roughness so that it grinds small metal particles from the work and then these particles are pounded into the surface of the work to lower the luster and darken the color.

*Point 7*—Keep the burnishing shot clean and brilliant for best results.

The matter of size of barrel loads frequently is overlooked even by relatively experienced operators. If one piece of work were to be burnished at a time, a fine looking job could be turned out in most cases. However, if a half barrel load of work were to be tumbled, alone without any burnishing shot being present, there is a good likelihood that the pieces would be nicked badly from collision between parts. The nicking is more pronounced with larger sizes and heavier pieces than would be the case with small, relatively light work. Obviously, between the uneconomical condition where only one piece is tumbled and the damaging condition where no shot is used and pieces collide and nick, there must be some point where a reasonable load of parts can be tumbled and an acceptable finish obtained. Just where this point is, must be determined by trial in the equipment available. However, a ratio of 3 volumes of shot to 1 of work is a fairly average value for work ranging from 1 to 2 inches in major length and for larger parts higher ratios will be found best in practice.

*Point 8*—Avoid too low a ratio of shot to work.

Let us now consider the matter of burnishing soap or compound. While soap was used exclusively years ago, today most ball burnishing is done with a "built" soap or compound. It is recognized that most industrial water contains varying amounts of calcium, magnesium, and iron salts. These salts react with the soap to form insoluble soaps which are useless for burnishing and which are sticky in character, adhering to the work and spoiling the color and brilliance of the finished material. Burnishing compounds usually contain appreciable amounts of water softening ingredients which prevent the curd formation. In addition, most compounds contain buffers which maintain the burnishing solution at the proper *p*H. It is found in practice that compounds preferred for steel may not be entirely suited to brass or aluminum because brass may tarnish or aluminum may pit when tumbled with a compound designed for steel. On the other hand, carbon steels and cast iron may pit when tumbled with compounds designed for aluminum. Zinc-base die castings present

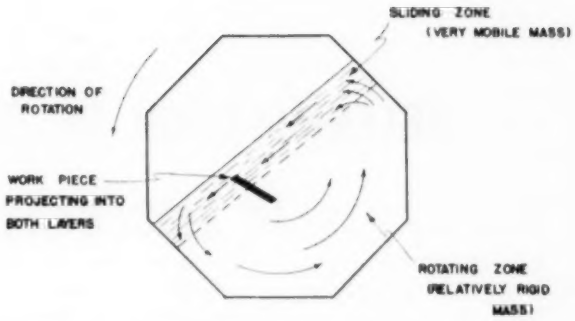


*Fig. 7. Action within the burnishing barrel*

another problem, since generally a different type of compound is best for these alloys. In addition, compounds may contain detergents, lubricants, and other special chemicals. As a result of differences in the chemical activity of different metals, it may be found desirable to use several different compounds in burnishing operations.

*Point 9*—Choose the proper compound for the job for maximum brilliance and luster.

While on the subject of burnishing compounds, attention should be called to a matter that is often overlooked and yet is a very common cause of trouble in barrel burnishing. As a rule, burnishing compounds are used at a concentration of about 1 oz/gal of water. As far as chemical solutions in the plating room are concerned, this is a very dilute solution. Cleaners may operate at 6–12 oz/gal; plating solutions from 6–50 oz/gal, and acid dips from 6–120 oz/gal. Now if chemicals are dragged into the burnishing barrel from plating solutions or acid dips—and this is a very easy thing to do when the work has cup-shaped recesses or where flat pieces tend to form closely packed stacks—these acids and salts may react with the burnishing compound or soap and produce discoloration or pitting of the work and shot. Obviously, with concentrated solutions such as described above, only a small amount need be dragged into the burnishing barrel to spoil completely the burnishing solution.

*Point 10*—Be sure to rinse all work thoroughly in good clean water. If necessary, use two rinse tanks before putting the work in the tumbling barrel.

While the above ten points do not cover all of the problems in ball burnishing, the author feels that close adherence to the above rules will overcome the vast majority of the difficulties encountered in practice. It has been the writer's purpose to try to explain some of the underlying principles involved so that the operator can apply these ideas to his own problem in an intelligent rather than a hit-or-miss manner.


### Acknowledgment

The writer wishes to thank Mr. R. E. Moore for his aid in preparing the drawings and photographs.

# DETERMINATION OF FREE CYANIDE AND ZINC IN ZINC CYANIDE SOLUTIONS*

R. F. MURACA†

## Introduction

The relative concentrations of zinc and cyanide in zinc plating solutions profoundly affect the properties of the deposit and the operation of the bath. It is common knowledge that the ratio of zinc to the total sodium cyanide content must be maintained at a definite value (1:2.8), depending upon the temperature, for proper operation of a zinc plating bath.[1] In addition, the total concentrations of zinc, hydroxide, and cyanide must be controlled in order to permit proper operation of the plating bath. Thus, it is of the utmost importance to have accurate methods for analyzing zinc solutions.

The usual methods of analyzing zinc plating solutions for total cyanide content[2] involve a modification of Liebig's argentimetric titration of cyanide.[3] More appropriately, these methods employ Denige's modification, which consists of the detection of the end point with potassium iodide in an ammoniacal medium.[4] However, the amounts of ammonia and iodide must be closely controlled, otherwise the end point may appear too early or too late.[5] The analysis for total cyanide fails or yields erratic values in the presence of iron, copper, or other substances which tightly complex cyanide ion, and even *p*H and carbonates seriously affect the results. A series of excellent articles by Heiman[6, 7, 8, 9, 10] presents the available methods for the determination of cyanide in brass plating baths and shows the limitations of each method. It is of interest to note that none of the procedures currently in use for determining cyanide makes use of an electrometric end point.

The determination of zinc in plating solutions generally involves a titration with standard ferrocyanide solution with either an external indicator or an internal indicator such as diphenylamine.[11] The procedure is not very easily carried out since the end point is somewhat indistinct and at times even erratic. The presence of almost any metallic element will lead to error since the end point is determined by the oxidation-reduction potential of the ferrocyanide-ferricyanide couple which, in turn, is influenced by the ferrocyanide ion concentration that remains unprecipitated by metal ions. Furthermore, the presence of cyanide and hydroxide affects the results. The titration is nearly empirical, for in order to obtain accurate results (± 0.3 per cent), the conditions of the titration must be rigidly controlled and should be identical with the standardization. Even the rate of addition of ferrocyanide must be controlled. Thus, the usual procedure for the analysis of zinc solutions leaves much to be desired.

## Definition of Free Cyanide

"Free cyanide" is generally defined in two ways:

1. The sodium cyanide in excess of the amount required to keep all metal compounds in solution.[12]
2. The sodium cyanide in excess of the amount required to form a metallic complex cyanide corresponding to a definite formula, *e.g.*, $Na_2Zn(CN)_4$.[13]

The first definition merely specifies a physical condition of the solution and outwardly does not concern itself with an exact description of the chemical composition of the solution. The practical electroplater generally interprets this definition as a specification of the solvent action of the solution on a metal surface. Since the solution contains no "free cyanide," it is assumed that the bath cannot dissolve metal of the same composition which is represented by the metallic constituents in the bath. Such an interpretation, although widespread, cannot be substantiated because a bath containing zinc, copper, and enough cyanide to produce a clear solution will dissolve brass of a similar composition. This comes about because the stability of the tricyano-copper complex is so much greater than the stability of the tetracyano-zinc complex that the copper metal in the brass will be preferentially dissolved and the tetracyano zinc complex in solution will be decomposed to furnish the necessary cyanide ions.

Furthermore, the first definition is dependent upon other conditions. For example, the amount of cyanide

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required to produce a clear solution of zinc is determined by the concentration of sodium hydroxide and may even be essentially zero:

$$4\ NaOH + Zn(CN)_2 \rightleftharpoons Na_2ZnO_2 + 2\ NaCN + 2\ H_2O$$
$$Zn(OH)_2 + 2\ NaOH \rightleftharpoons Na_2ZnO_2 + 2\ H_2O$$

It is assumed that the insoluble portion of an alkaline zinc bath is either zinc cyanide or zinc hydroxide. Even temperature and the presence of other substances such as carbonates and ferrocyanides profoundly influence the value of "free cyanide" described by the first definition. Thus, the first definition is of value for "rule of thumb" procedures or for practical utility where the chemical significance of the definition is ignored.

The second definition seeks to specify a condition which is rational and which can be measured exactly by some means. However, the definition as given does not specify the conditions under which measurements are made. In the case of a zinc cyanide solution the alkalinity will determine the amount of free cyanide:

$$Na_2Zn(CN)_4 + 4\ NaOH \rightleftharpoons Na_2ZnO_2 + 4\ NaCN + 2\ H_2O$$

This is also the fundamental difficulty involved in the determination of free cyanide in plating baths, for under a given set of conditions there exists a definite amount of free cyanide and the methods for determining cyanide (such as titration by silver nitrate) disturb the equilibrium by removing the free cyanide.

Most analytical procedures for determining "free cyanide" in zinc solutions are based upon this definition in that free cyanide is considered to be the sodium cyanide in excess of the amount required to complex the entire zinc content of the bath; the formula of the zinc complex is also defined. Although such a definition discloses nothing about the free cyanide content of the bath under operating conditions, it affords a satisfactory procedure for controlling plating baths. To a certain extent, it may be assumed that the "free cyanide" determined as indicated above will be added to the cyanide ion given up by the zinc complex under the conditions of operation of the bath. In fact, practice has shown that the effects attributable to free cyanide are nearly directly relatable to the "free cyanide" as determined by this definition.

## A New Definition

The second definition given above indicates that "free cyanide" should be determined as sodium cyanide thus giving the impression that the gross concentration of sodium cyanide in the bath is responsible for whatever effects are attributable to free cyanide. This would be true in very dilute solutions but, in concentrated solutions such as are encountered in plating baths, the *activity* of the cyanide ion is the governing factor and, unfortunately, the activity is not linearly related to the concentration and is severely affected by the presence of large quantities of "inert" salts. Thus, the proper procedure for evaluating "free cyanide" would not disturb the equilibrium conditions in the bath and would yield values for the *activity of the cyanide ion*. Such a procedure is currently being used for the determination of the activity of the hydrogen ion (*p*H). On the basis of these observations, the following definition of "free cyanide" is proposed: Free cyanide is the activity of the cyanide ion expressed as sodium cyanide in the bath at operating conditions.

This definition is, of course, an ideal one, but to date no procedure for measuring the activity of the cyanide ion has been developed. In fact a simple, practical procedure for measuring the activity of the cyanide ion will be subject to even more errors than the determination of the *p*H of concentrated solutions.

## Experimental

The electrometric titration of zinc cyanide solutions was investigated by Glasstone[14] and it was found that $Na_2Zn(CN)_4$ is the only complex of zinc and cyanide which forms in dilute solutions. On the premise that the potential of the system

$$Zn,Zn^{+2},Zn(CN)_4^{-2} \,||\, KCl,Hg_2Cl_2,Hg,Pt$$

is the function of the cyanide ion concentration, since

$$Zn^{+2} + 4\ CN^- \rightleftharpoons Zn(CN)_4^{-2},$$

it should be possible to determine the activity of the cyanide ion in zinc cyanide solutions by measuring the voltage developed between zinc and calomel electrodes. It was realized that *p*H and temperature, among other things, would influence the results. Furthermore, it was recognized from the start that the value of all electrometric results are strongly dependent upon whether equilibrium can be established between the metal and its ions.

### *Apparatus*

The apparatus used for all electrometric measurements consisted of a 250-ml beaker into which was placed a mechanical stirrer, the electrodes of a *p*H meter (Beckman Model G), a metal electrode, and a saturated calomel electrode. The glass electrode (Beckman 1190) was made of "general purpose glass" and so required correction for sodium ion concentration at high *p*H values.

A 50-ml burette was arranged in position for titrations. A bar of pure zinc was used as a zinc electrode. A small thermometer was mounted in the beaker to measure the temperature during titration. The potential developed between the calomel electrode and the metal electrode was measured with a vacuum tube millivoltmeter built by the author. This voltmeter has an input impedance of 50 megohms with a 1-volt range capable of being read to the nearest 2 millivolts. Any of the modern high impedance voltmeters, such as *p*H meters, can be used to measure the potential.

### *Results*

A preliminary titration of 100 ml of 0.1 molar NaCN with 0.1 molar NaCN with 0.1 molar $ZnSO_4$ indicated that equilibrium between zinc metal and its ions in cyanide solution was achieved too slowly for use in

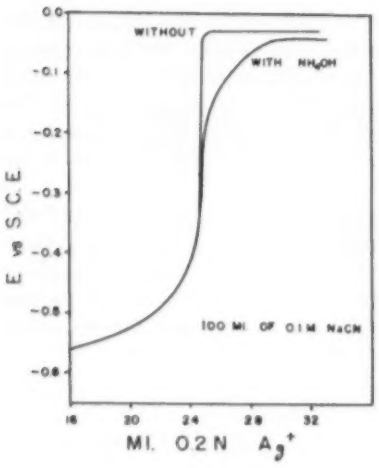


*Fig. 1. Potentiometric titration of 100 ml of 0.1 molar NaCN with 0.2 molar $AgNO_3$, using a silver electrode. The ammonia concentration is 0.75 molar*

practical titrations. The potential remained at about −1.3 volts *versus* saturated calomel electrode until about half of the cyanide was consumed, and then the voltage slowly dropped until nearly all the cyanide was consumed. The voltage in the vicinity of the equivalence point quickly dropped to about −1.0 volt and then leveled off at about −.05 volt. The end point break was large, but equilibrium was slowly achieved.

For contrast, the same titration was run using 100 ml of 0.1 molar $AgNO_3$ with a calomel-silver electrode system (silver electrode; Sargent S-30515). Equilibrium was quickly established at all times and repeated titrations were closely comparable point for point along the parts of the curve where either excess cyanide or silver were present (Fig. 1).

Since the lower part of the curve indicated that the silver ion concentration in solution (and so the potential developed between silver and calomel) is sensitive to the cyanide concentration, it was decided to use the silver electrode as an indicator of free cyanide. The silver ion concentration measured by the silver electrode potential is the result of the equilibrium:

$$Ag(CN)_2^- \rightleftharpoons Ag^+ + 2\,CN^-$$

Pilot experiments quickly revealed that when different electrodes were immersed in various baths containing different ratios of cyanide and zinc as well as different hydroxide concentrations, the potentials were not strictly reproducible. Hence, the idea of using a silver electrode or a zinc electrode as an indicator of free cyanide was abandoned.

The chief factor which controls the potential developed between an electrode and the solution in which it is immersed is the concentration of its ions. This potential is given by the familiar Nernst equation:

$$E = -0.81 - 0.059 \log (Ag^+).$$

If it be assumed that there are almost no silver ions in the solution containing cyanide, when silver metal is immersed in it, the above equation shows that the silver will assume an extremely high potential with respect to the solution. Thus, some silver must dissolve and the concentration of silver at the electrode-solution interface will increase in an effort to relieve the electrical stress. Under these conditions, the rate of diffusion of silver ions away from the interface will control the potential which the silver metal will assume. Further, the diffusion of cyanide into the interface will also control the silver ion concentration at the interface. In concentrated solutions of cyanide, the rate of diffusion of cyanide will be so high that the rate of solution of the silver metal will control the developed potential. Thus, the surface area and surface characteristics of the silver electrode are involved in such measurements.

When a metal is immersed in a strong solution of its ions (*ca.* 0.005–0.20 molar), the solution tendency is decreased and a true equilibrium is established between the metal and its ions. Since large amounts of the metal electrode do not have to dissolve to maintain an equilibrium with its ions in the interface, the equilibrium is achieved rapidly and for all practical purposes is independent of the condition of the metal surface. Pilot experiments showed that silver electrodes immersed in solutions of silver nitrate or sodium argentocyanide quickly assumed stable, reproducible potentials (± 0.001 volt).

*Liebig's titration*

The titration of sodium cyanide by silver ion proceeds smoothly. Typical results are shown in Fig. 1. When the potential rises above −0.15 volts, a precipitate appears. *Denige's modification* of Liebig's titration involves the use of potassium iodide as an indicator in the presence of ammonia. The ammonia serves chiefly to maintain the *p*H at a fixed level and to dissolve certain silver salts which may form during the titration.

By inspection of Fig. 1, it becomes apparent that the equivalence point of the Liebig titration is in the vicinity of −0.150 volts *versus* the saturated calomel electrode; although it is granted that an end point value in the vicinity of −0.300 volts *versus* the saturated calomel electrode would suffice for all practical purposes. In the titration curve with ammonia, the end point value of −0.300 volt practically coincides with the Liebig titration.

A value of −0.300 volts *versus* the saturated calomel electrode means that the silver ion concentration is:

$$-0.26 - (-0.30) = -0.81 - 0.06 \log (Ag^+)$$
$$(Ag^+) = 10^{-14}$$

where −0.26 is the value of the saturated calomel electrode with respect to the normal hydrogen electrode. The concentration of iodide ion theoretically required to precipitate silver iodide at this concentration of silver ion is given by the solubility product relation:

$$(Ag^+)\,(I^-) = 1 \times 10^{-16}$$

and when $(Ag^+) = 10^{-14}$, $(I^-) = 10^{-2}$

Any deviation from this iodide ion concentration will lead to error. Generally, the amount of iodide that is added is too great and so the end point is premature.

Fig. 1 also shows the type of curve which is obtained when cyanide in the presence of ammonia is titrated with silver nitrate. The presence of ammonia tends to reduce the sharpness of the end point break in the elec-

trometric titration and so makes it somewhat more difficult to obtain accurate results. However, the end point indication in the usual analyses when titrating to the first permanent opalescence is more easily perceived in the presence of ammonia and potassium iodide than without as in Liebig's original procedure.

### Experiments with Zinc Cyanide Solutions

Solutions of zinc sulfate (1 molar), sodium cyanide (1 molar), and silver nitrate (0.200 molar) were made up and accurately standardized. The silver nitrate solution was standardized with dry potassium chloride using fluorescein as an adsorption indicator. It was found that reagent grade silver nitrate dried at 110° C for several hours yielded solutions 0.2000 ± 0.0003 when made by dissolving 33.978 g. of the salt and diluting to exactly one liter. The zinc sulfate solution was standardized by titrating with ferrocyanide and determining the end point electrometrically. The sodium cyanide was standardized before use by an electrometric titration (Fig. 1). By mixing appropriate amounts of these solutions, it was possible to make zinc cyanide solutions of different known concentrations.

#### *Liebig's titration of zinc cyanide solutions*

Fig. 2 shows the titration curve of a 0.01 molar solution of $Na_2Zn(CN)_4$, containing excess cyanide, using a silver electrode. The initial portion of the curve is not always reproducible since the concentration of silver ions in the bath is initially quite small and equilibrium values are not achieved.

Liebig's method with a visual endpoint is not applicable to the determination of total cyanides in the presence of zinc since a precipitate of zinc hydroxide or cyanide appears when half of the cyanide content is complexed by silver. It is extremely interesting to note, however, that the precipitation of the zinc salt tends to maintain the concentration of silver ion and the *p*H constant. Before turbidity appears, the free cyanide and the cyanide from the dissociation of $Zn(CN)_4^{-2}$ is titrated. As the amount of the free sodium cyanide gradually decreases, the alkalinity decreases and zinc no longer can remain as zincate so it precipitates. When all the cyanide has been complexed (above E = −0.15), silver cyanide precipitates and maintains the silver ion concentration at a fixed value.

#### *Denige's titration of zinc cyanide solution*

The results of titrating an ammoniacal 0.01 molar solution of $Na_2Zn(CN)_4$ containing excess cyanide are shown in Fig. 3. Since zinc hydroxide is soluble in ammonia, no precipitate forms prior to the titration of the total cyanide content, and no distinct end point break appears in the titration curve. Thus, when potassium iodide is used to effect visual determination of the end point, small variations in the concentration of iodide will cause rather large errors.

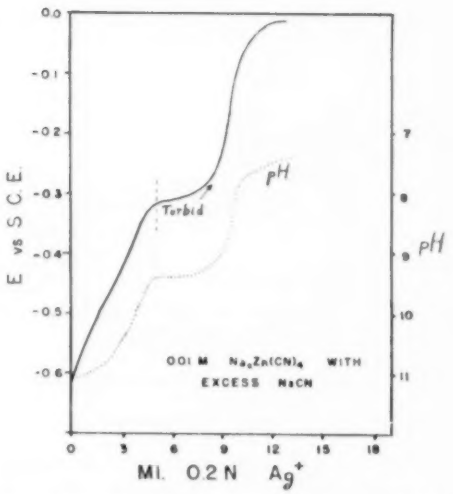


*Fig. 2. Potentiometric titration curve of 0.01 molar $Na_2Zn[CN]_4$, containing excess NaCN. Potential difference —; pH - - - -*

### Experiments with Zinc Cyanide—Silver Cyanide Solutions

Preliminary experiments with solutions containing zinc and cyanide had shown that the potential of the silver electrode was not reproducible at the start of the titration until a sufficient amount of silver had been added. Furthermore, it was noticed that the *p*H of the medium greatly affected the potential of a silver electrode immersed in a solution of zinc cyanide containing silver cyanide.

The effect of *p*H on the potential developed between a silver electrode and a saturated calomel electrode immersed in solutions, which are 0.1 molar in $NaAg(CN)_2$ and contain various amounts of $Na_2Zn(CN)_4$, is indicated in Fig. 4. The important thing to be noted is that a fourfold increase in concentration of

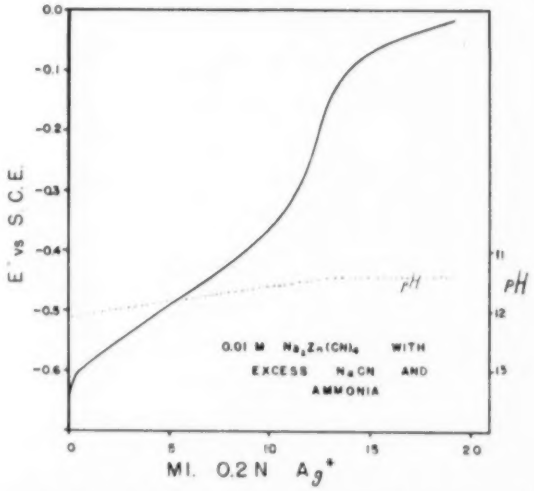


*Fig. 3. Potentiometric titration curve of ammoniacal 0.01 molar $Na_2Zn[CN]_4$, containing excess NaCN. $[NH_4OH] = 0.75$ M*

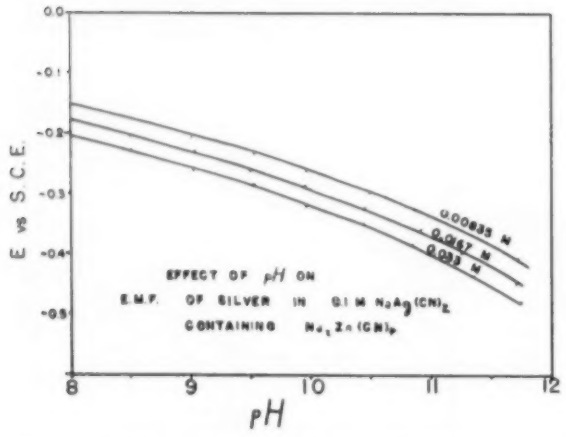


*Fig. 4. Effect of pH on the silver electrode potential of a solution 0.1 molar in $NaAg[CN]_2$ that contains $Na_2Zn[CN]_4$*

$Na_2Zn(CN)_4$ changes the potential only by 0.025 volt. Furthermore, the same curves, within 2 or 3 millivolts, were obtained by two operators each working in different laboratories. Thus, the voltage developed by a silver electrode immersed in 0.1 molar $NaAg(CN)_2$ containing $Na_2Zn(CN)_4$ is reproducible at *p*H values from 8 to 12.

*Titration of zinc cyanide solutions in $NaAg(CN)_2$*

A solution of 0.2 molar $NaAg(CN)_2$ was prepared by placing 600 ml of water in an 800-ml beaker, adding 19.6 gm of NaCN, and slowly adding (while stirring vigorously) 34 gm of $AgNO_3$ dissolved in about 100 ml of water. The solution was stirred for four hours during which time any precipitated silver salts were dissolved by the addition of small quantities of NaCN. The silver electrode and calomel cell were next immersed in the solution and the potential measured. By the addition of 0.2 molar $AgNO_3$ or 1 molar NaCN solution, the voltage of the silver electrode was adjusted to $-0.20$ *versus* saturated calomel electrode. After standing several hours, the voltage was checked and the solution was filtered and diluted to 1 liter.

Titration curves for solutions of $Na_2Zn(CN)_4$ containing excess cyanide were carried out as follows: A solution of 0.1 molar $Na_2Zn(CN)_4$ containing excess cyanide was prepared by diluting 10 ml. of 1 molar zinc sulfate and an appropriate amount of 1 molar sodium cyanide solution to 100 ml. Then, samples of this solution were pipetted into a 250-ml beaker together with 50 ml of 0.2 molar $NaAg(CN)_2$ and enough water was added to bring the volume to about 100 ml.

Preliminary experiments had shown that the voltage developed by the silver electrode in solutions of this kind was not greatly influenced by as much as a two-fold dilution. Thus, it was not necessary to dilute these solutions accurately, and the addition of less than 50 ml of titrant would not affect the value of the measured voltage (0.005 volt) provided the *p*H after dilution was adjusted to the initial value (Fig. 4).

In the usual zinc plating bath, there is a high concentration of sodium salts for cyanide or hydroxide is constantly added to maintain given levels of these substances. Thus, if a sample of a zinc plating bath were to be titrated with silver nitrate in the presence of 0.1 molar $NaAg(CN)_2$, the voltages developed by the silver electrode would be affected by the high concentrations of diverse ions introduced by the bath. Since the activity of a univalent ion is nearly constant in solutions of ionic strengths of the order of 0.4, the solutions of zinc cyanide in 0.1 molar $NaAg(CN)_2$ used in the following experiments were brought up to this ionic strength by the addition of an appropriate

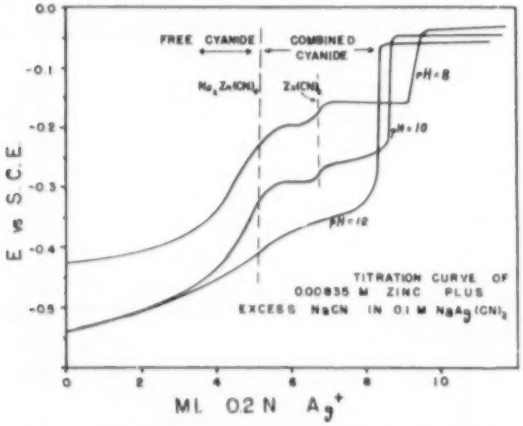


*Fig. 5. Titration curves at different pH values of a solution 0.1 molar in $NaAg[CN]_2$ and 0.00835 molar in zinc ions, containing more NaCN than is required to form $Na_2ZN[CN]_4$. The ionic strength is 0.4. When corrected for sodium ion concentration effects on the glass electrode, the 12 pH value is actually 11.70*

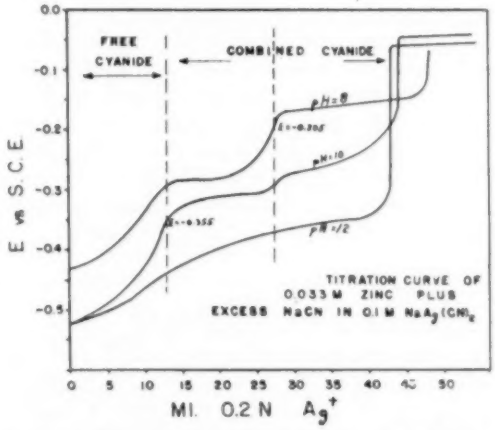


*Fig. 6. Potentiometric titration curves at different pH values of a solution 0.1 molar in $NaAg[CN]_2$ and 0.033 molar in zinc ions, containing more NaCN than is required to form $Na_2ZN[CN]_4$. The ionic strength is 0.4. When corrected for sodium ion concentration effects on the glass electrode, the 12 pH value is actually 11.7*

amount of sodium nitrate. Further experiments showed that the addition of rather large quantitites of salts such as $NaNO_3$ or NaCl did not appreciably affect the measured voltages.

Figs. 5 and 6 show the titration curves of 0.00835 molar $Na_2Zn(CN)_4$ and 0.0333 molar $Na_2Zn(CN)_4$ containing excess NaCN. The *p*H was maintained at the indicated values by the addition of small quantities of strong $H_2SO_4$ or KOH. The sodium ion correction for each solution was applied to the *p*H values as read on the *p*H meter; KOH was used to maintain *p*H values since it did not disturb the values of the sodium ion concentrations calculated from the sodium cyanide added to the solutions. After each addition of titrant, at least 3 minutes were allowed to elapse before the potential of the silver electrode was measured.

The effect of *p*H on these titrations is quite startling. In the first place, titrations at *p*H 12 give no indication of the formation of zinc cyanide or of the titration of the cyanide in excess of $Na_2Zn(CN)_4$. On the other hand, they give the correct value for the total cyanide content with a large end point break. Potential measurements in the vicinity of the end point are slow to come to equilibrium. This titration is similar to that proposed by Heiman and McNabb[6] in that it is a titration of total cyanide in strongly alkaline solution.

The titrations at *p*H 8 and 10 give incorrect values for total cyanide but both give accurate indications of the value of free cyanide. At *p*H 10, the end point break for the excess cyanide is larger and better defined than at *p*H 8; on the other hand, the end point break corresponding to the titration of cyanide in excess of $Zn(CN)_2$ is better defined at *p*H 8 than at 10.

These curves were reproduced many times using different silver electrodes and new solutions.

The effect of the presence of carbonate and ammonia was found to influence the shape of these curves. For example, while ammonia affects the titration curves at any *p*H value, carbonate affects the titration mostly at *p*H 8. Fig. 7 shows the depressing action of large amounts of carbonate.

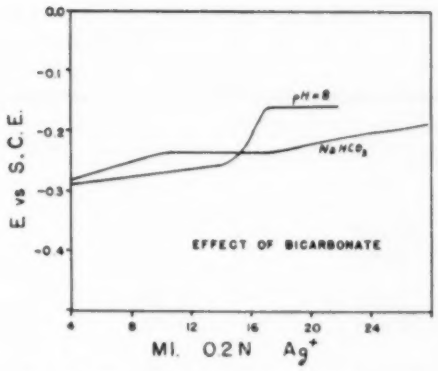


*Fig. 7. The effect of $NaHCO_3$ [pH = 8.15] on the potentiometric titration curve of a solution of $Na_2Zn[CN]_4$ in 0.1 molar $NaAg[CN]_2$. pH = 8*

## Proposed Procedure for Cyanide Analysis

On the basis of the results indicated in Figs. 4, 5, and 6, the following procedures for the analysis of zinc cyanide solutions are suggested. Fig. 8 indicates the scheme of analysis.

By adding 0.2 molar $AgNO_3$ to a solution of 0.1 molar $NaAg(CN)_2$ containing a sample of zinc cyanide maintained at *p*H 10, the cyanide in excess of $Na_2Zn(CN)_4$ is indicated by the volume of $AgNO_3$ needed to bring the potential developed between silver and saturated calomel electrodes to −0.355 volt. The solution is then adjusted to *p*H 8; the potential rises to about −0.3 volt. Silver nitrate solution is added until the potential of the silver electrode becomes −0.205 *versus* saturated calomel electrode, meanwhile maintaining *p*H = 8. The volume of silver nitrate required indicates the cyanide in excess of $Zn(CN)_2$. Then potassium hydroxide is added to the solution to bring it up to *p*H 12. The potential drops to about −0.33 volt. Silver nitrate is added until the potential of the silver electrode becomes −0.10 volt *versus* saturated calomel electrode while the *p*H is maintained at 12. This volume of silver nitrate corresponds to the cyanide bound as $Zn(CN)_2$.

*Procedure A*

This procedure for analyzing zinc cyanide solutions assumes that the sample may contain cyanide in excess of that required to complex the entire zinc content as $Na_2Zn(CN)_4$ and that the $Zn(CN)_2$ content is: 6–10 oz/gal.

(1) Transfer a 5-ml sample of the bath to a 250-ml beaker. Add 35 ml of water and 2-3 gm of KOH. Place a watch glass on the beaker. Note the level of the solution in the beaker.

(2) Boil the solution gently for at least 10 minutes to remove ammonia. Cool quickly by putting the beaker in cold water.

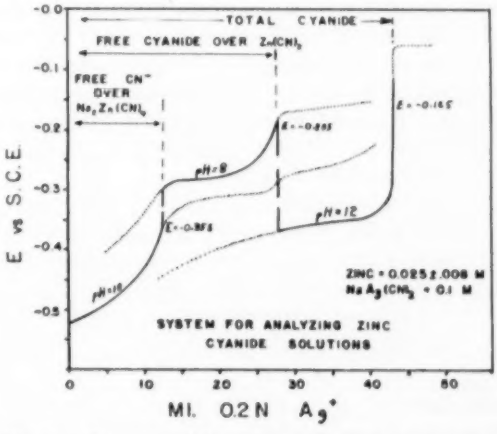


*Fig. 8. Diagram of the scheme of analysis for cyanide in zinc cyanide solutions. The indicated values are applicable to solutions that are 0.025 ± 0.008 molar in zinc and are 0.1 molar in $NaAg[CN]_2$*

TABLE I. RESULTS OF ANALYSIS OF SYNTHETIC ZINC CYANIDE SOLUTIONS
(Different size samples of each solution were used)
(All values in ounces per gallon)

| Solution | Sodium Cyanide | | | Zinc | Ratio (NaCN) / (Zn) |
|---|---|---|---|---|---|
| | *p*H = 10 | *p*H = 8 | *p*H = 12 | | |
| 1 Actual | 0.60 | 3.10 | 9.75 | 4.24 | 2.30 |
| Theory | 0.60 | 3.18 | 9.75 | 4.25 | 2.29 |
| 2 Actual | 0.60 | 0.06 | 6.55 | 4.25 | 1.54 |
| Theory | 0.60 | 0.00 | 6.55 | 4.25 | 1.54 |
| 3 Actual | 1.41 | 8.07 | 13.25 | 4.25 | 3.12 |
| Theory | 1.45 | 8.07 | 13.28 | 4.25 | 3.12 |
| 4 Actual | 0.60 | 0.00 | 4.44 | — | — |
| Theory | 0.60 | 0.00 | 4.38 | — | — |
| 5 Actual | 0.60 | 6.51 | 13.10 | 4.25 | 3.08 |
| Theory | 0.60 | 6.55 | 13.10 | 4.25 | 3.08 |
| 6 Actual | 0.991 | 6.92 | 12.84 | 4.25 | 3.02 |
| Theory | 0.975 | 6.94 | 12.90 | 4.25 | 3.03 |

(3) Add enough water to restore the volume of solution lost by boiling. Add 10 ml of 5 per cent $BaCl_2$ solution to precipitate any carbonate.

(4) Add 50 ml. of 0.2 molar $NaAg(CN)_2$ solution.

(5) Put the beaker in position in the electrometric titration apparatus.

(6) Adjust the solution to *p*H 10 by adding tiny drops of 1:3 sulfuric acid or 40 per cent KOH as needed.

(7) Titrate with 0.200 molar $AgNO_3$ to a potential of −0.355, maintaining the *p*H at 10 during the titration and especially at the end point. Record the volume of $AgNO_3$ used. (A).

(8) Adjust the solution to *p*H 8 by the cautious addition of acid.

(9) Titrate with 0.200 molar $AgNO_3$ to a potential of −0.205, maintaining the *p*H at 8. The equilibrium voltage is achieved slowly in the vicinity of the end point. Therefore, add only 0.2 ml of $AgNO_3$ at a time when the potential reaches −0.280 and then only a drop at a time thereafter. Wait for equilibrium. Record the volume of $AgNO_3$ used. (B).

(10) Adjust the solution to *p*H 12 by adding 40 per cent KOH. Titrate with 0.200 molar $AgNO_3$ to a potential of about −0.32 and then drop-by-drop, slowly approach the equivalence potential −0.100 volt while maintaining *p*H 12. Record the volume of $AgNO_3$ used. (C).

*Calculations:*

Total cyanide as NaCN
oz/gal = ml (A + B + C) x 0.524

Free cyanide as NaCN in excess of $Na_2Zn(CN)_4$
oz/gal = ml A x 0.524

Free cyanide as NaCN in excess of $Zn(CN)_2$
oz/gal = ml (A + B) x 0.524

*Procedure B*

For solutions which contain from 8–10 oz/gal of $Zn(CN)_2$ and not enough NaCN to form $Na_2Zn(CN)_4$, a titration to *p*H 10 is unnecessary. In these solutions, the ratio $\frac{(Zn(CN)_2)}{(NaCN)}$ is less than 1:2. Follow procedure A, omitting steps (6) and (7). In the calculations, the ml of $AgNO_3$ corresponding to the titration at *p*H 10 will be zero, that is A = 0.

## Results of Cyanide Analysis

Solutions containing different amounts of zinc and cyanide with and without excess NaOH were made up and analyzed in accordance with procedure A. The results shown in Table I clearly indicate the validity of the procedure. Bath No. 6 contained, in addition to cyanide and 0.1 mole of zinc, 0.1 mole of sodium carbonate, 0.01 mole of $K_4Fe(CN)_6$, and 0.1 mole of ammonium chloride. The excellent results obtained with a solution containing such a high concentration of substances which might interfere definitely establish the value of the procedure.

## Determination of Zinc

The need for a rapid and accurate method for the determination of zinc in plating solutions is quite obvious to all platers. The theory and the chelatometric determination of zinc by means of ethylenediaminetetraacetic acid (EDTA) has been described by Schwarzenbach, *et al.*[15, 16, 17, 18]

Unfortunately, EDTA forms complexes with almost

all metallic elements in basic solutions so that it is not generally applicable for metal analyses without prior separation or masking of interfering substances. Kinnunen[19] has shown that it is possible to determine zinc in metallurgical products by masking copper, cobalt, etc., with cyanide and then releasing the zinc from its cyanide complex by the addition of formaldehyde. The tightly bound cyanide in the copper and cobalt complexes is not destroyed by formaldehyde. The following procedure makes use of an EDTA titration in the presence of cyanide for the determination of zinc.

*Procedure for zinc analysis*

This procedure is designed for plating baths containing from 6–10 oz/gal of $Zn(CN)_2$ or 3–5 oz/gal of zinc in acid zinc baths.

*Reagents*:

(1) Ethylenediaminetetraacetate solution—Dissolve exactly 74.42 gm. of reagent grade disodium ethylenediaminetetraacetate dihydrate in a solution of 9 gm NaOH in 200 ml of water and dilute to exactly one liter. This solution may be assumed to be 0.2000 molar or it can be standardized with pure zinc metal.

(2) Buffer solution—Dissolve 54 grams of $NH_4Cl$ in water, add 350 ml of concentrated $NH_4OH$ and dilute to about one liter.

(3) Eriochrome Black T solution—Dissolve 0.2 gm of Eriochrome Black T in about 50 ml of methanol.

(4) Formaldehyde solution—Dilute 35 per cent formalin with an equal volume of water.

(5) Sodium cyanide solution—5 molar.

*Procedure*

(1) Transfer 10 ml of the bath to a 250-ml Erlenmeyer flask.

(2) If the solution is acid, add sodium hydroxide solution until a permanent precipitate of zinc hydroxide is just formed. Then add 5 ml of 5 molar NaCN, mix well, and carefully add $H_2SO_4$ until a permanent precipitate results. If the solution is basic, add dilute sulfuric acid until a precipitate just forms.

(3) Add 25 ml of buffer solution and 20 ml of water.

(4) Add 3 drops of Eriochrome Black T indicator solution.

(5) Add 5 ml of formaldehyde solution; if the indicator is not red, add 5 ml more.

(6) Titrate with EDTA until the indicator changes to a blue color. Add 5 ml of formaldehyde; if the indicator turns red, continue the addition of EDTA. Repeat the addition of formaldehyde at the end point.

(7) Record the volume of EDTA used.

*Calculation*

oz/gal of zinc = ml EDTA x 0.171

oz/gal of $Zn(CN)_2$ = ml EDTA x 0.312

*Remarks*

The titration of zinc by EDTA is not affected by carbonate, ferrocyanide, ferricyanide, cobalt, copper, iron, chromium, and aluminum. However, cadmium, calcium and magnesium are titrated by EDTA in ammoniacal medium. Thus, calcium and magnesium salts will interfere. The calcium and magnesium content of basic zinc baths is likely to be low, but acid zinc baths may contain large quantities of calcium and magnesium salts. The excellent results obtained with this procedure are indicated in Table I.

## Summary

The two definitions of free cyanide which are in general use are discussed and a new one is proposed based upon the activity of the cyanide ion. Liebig's procedure for determining cyanide and Denige's modification are discussed with respect to their potentiometric titration curves.

It has been found that the potentiometric titration of 0.03 molar zinc cyanide solutions in 0.1 molar $NaAg(CN)_2$ at *p*H 10, 8, and 12 yield results for cyanide in excess of $Na_2Zn(CN)_4$, cyanide in excess of $Zn(CN)_2$, and total cyanide, respectively. These facts become the basis of a procedure for analyzing zinc cyanide solutions.

A procedure for the analysis for zinc in either acid zinc plating solutions or basic zinc cyanide plating baths based on an EDTA titration is described.

## Acknowledgment

The author gratefully acknowledges the assistance of Messrs. L. L. Lehr, Jr., and J. P. Bonsack during the early stages of this work.

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## DISCUSSION

DR. WALTER MEYER (Enthone, Inc., New Haven, Conn.): Dr. Muraca has developed a rather interesting method for analysis that may have more important uses with respect to other plating solutions. I think the average plater who realizes that sodium cyanide and sodium hydroxide play almost equally important roles will agree with what Dr. Muraca said. One can notice from the curves that the effect of *p*H was about as important as the effect of cyanide on the potential.

We are interested in the actual electrode potential. I wonder if this method would not be more applicable in determining the deposition potential of simple solutions such as a copper or a brass plating solution?

DR. MURACA: I have tried it in the presence of copper and it seems to work pretty well. I have not really investigated all the phases of the work so that I can not say today that I think this method of analysis is applicable to brass or bronze plating solutions.

I am sure that the presence of small quantities of copper does not affect the titration curves, for the cyanide that is present with the copper is not titratable by silver. That really is not part of free cyanide anyway but a part of the total cyanide content, the *absolute total cyanide* content of a solution, and that is not what a plater is after. He is interested mostly in the *active cyanide* that is available for anode corrosion rather than the total cyanide that is tied up in the solution. I am not absolutely sure what the story will be in the presence of large amounts of copper in baths that are characteristic of brass and bronze plating solutions. I assure you it is under investigation—I would not miss something so simple.

MR. JOSEPH ZETKZ (Cadillac Motors, Detroit, Mich.): Nothing was said about sulfides. Is there in your analysis any interference by the sulfide used as zinc brightener?

DR. MURACA: I know that if sulfide is present in the 0.1 molar silver cyanide solution, the sulfide will precipitate as silver sulfide and that it will be present as a sludge. In other words, the sulfide impurity is precipitated and dropped out of the picture.

MR. MYRON B. DIGGIN (Hanson-Van Winkle-Munning Company, Matawan, N. J.): What is the effect of the variation in temperature on the analytical results in the potentiometric determination of cyanide?

DR. MURACA: I did not mention temperature. In fact, there are many factors that I left out of a discussion of this type. Most of you realize that a technical paper like this can be blown up to last all afternoon, and I was not interested in doing that. You can read the final paper as it is published and will find there a lot more information than is presented here. In response to your question, the temperature does affect it. In fact, every 5° rise in temperature will raise the silver potential 1 millivolt, and generally speaking these titrations are carried out to plus minus 5 millivolts so that even on a hot day the titrations are sufficiently accurate. In spite of these small variations with temperature I carried out the titrations at a constant temperature of 25°.

MR. EMORY B. MICHEL (Thomas Strip Division, Pittsburg Steel Company, Warren, Ohio): How accurate would be the determination of the zinc concentration from the electrometic titration of the cyanide complexed with the zinc?

DR. MURACA: The determination of zinc by these procedures is possible only when there is enough cyanide to form the complex $Na_2\ Zn\ (CN)_4$. Under this condition, achieved normally in the sample or by the addition of cyanide, the concentration of zinc should be determined with an accuracy approaching that usually obtained in ferrocyanide titrations with an internal colorimetric indicator.

It is particularly interesting to note that titration errors are reduced by a factor of four since four cyanides combine with one zinc. These electrometric titrations permit the simultaneous determination of free cyanide, total cyanide, and zinc in solutions of $NA_2\ Zn\ (CN)_4 + NaCN$.

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# NICKEL PLATING FROM THE SULFAMATE BATH*

BY RICHARD C. BARRETT†

## Historical

Nickel plating from sulfamate solutions was first announced in 1938 by Piontelli[1] and Cambri in Italy. Although Piontelli and his co-workers[2,3,4,5,6,7,8,9,10] continued to report regularly upon their progress of plating from sulfamate solutions during the subsequent ten years, the bulk of their research was confined to the development of bath formulae for plating or electrowinning of lead.

Co-incidental with the announcement[11] of a commercial source of production of sulfamic acid in this country during the late 1930's, further interest was aroused domestically and several descriptions only of laboratory interest were published by Choguill,[12] Mathers,[13] and Forney.[14] In 1940 a patent was issued to Cupery[15] covering the plating of copper, nickel, and lead from sulfamate electrolytes.

During the ensuing ten years after the granting of the Cupery patent, no further published data upon nickel plating from sulfamate baths appeared on record until 1950 when Barrett[16] described a bath introduced to the electrotype industry late in 1949. As far as is known, this event marked the first reduction to practice in this country of any sulfamate plating bath for the electrodeposition of nickel upon a commercial scale.

Within the five-year period following 1949, more than 60 commercial sulfamate nickel plating baths were installed, comprising more than 50,000 gallons of solution. Such magnitude has made possible the collection of a large backlog of operating performance data, some of which are reported in this paper.

This new activity also encouraged further papers in the technical journals on sulfamate nickel plating as evidenced by the published discussions of Peters,[17] Gurnham,[18] and Barrett.[19] Recently, Diggin[20] presented a paper before the Fourth International Conference on Electrodeposition and Metal Finishing at London, in which he describes a nickel sulfamate-chloride bath.

The few references in the literature to sulfamate plating baths, the meager knowledge of the properties of the relatively new sulfamic acid, and the early high cost of the acid combined with a short supply of nickel during the years of World War II and continuing thereafter discouraged active interest in any new nickel plating process.

Because of many desirable physical properties of nickel deposits plated from sulfamate baths, particularly with reference to low internal stress and the significance of stress upon premature fatigue failure, the aircraft industry as well as others are now actively evaluating the sulfamate nickel plating bath. It is predicted that sulfamate nickel plating will eventually be as common as the familiar Watts nickel.

## Description of Solutions

Any description of sulfamate plating baths must of necessity start with a description of the unique properties of sulfamic acid and its salts.

Sulfamic acid is a white crystalline inorganic solid, nonhygroscopic and nonvolatile. It may be conveniently handled and stored. In strength and chemical structure it is very similar to sulfuric acid.[11]

Sulfuric Acid, $H_2SO_4$ Sulfamic Acid, $HSO_3NH_2$

The substitution of an amino group ($NH_2$) for one of the hydroxyl (OH) groups of sulfuric acid undoubtedly gives to sulfamic acid many of its unique properties which are reflected in the quality of electrodeposits obtained from its metal salts in solution.

Sulfamic acid is moderately soluble in water, yielding solutions which are highly acid and compare in *p*H range with those of the three common mineral acids, nitric sulfuric, and hydrochloric (Fig. 1).

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, July 13, 1954.

†Barrett Chemical Products Company, Shelton, Connecticut.

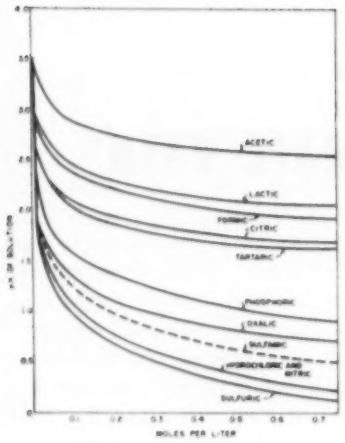


*Fig. 1. pH concentration curves comparing sulfamic acid with other acids*

The metal salts of sulfamic acid are extremely soluble and in many instances are the most soluble metal salts known (Table I). Nickel sulfamate, $Ni(NH_2SO_3)_2$, is so soluble that it cannot be successfully re-crystallized from solution. The solubility is many times that of single nickel salts or nickel chloride. Such high solubilities make it possible to build electrolytes with exceptionally high metal content—a desirable condition for high current density operation.

Sulfamic acid is monobasic and will react with metals, metal oxides, or metal carbonates to yield the corresponding metal sulfamate by simple replacement of one hydrogen atom associated with the hydroxyl group. The most common and easiest way of preparing nickel sulfamate is by reaction of a solution of the acid with nickel carbonate:

$$NiCO_3 + 2NH_2SO_3H \rightarrow Ni(H_2NSO_3)_2 + H_2O + CO_2$$

Sulfamic acid and its salts slowly hydrolyze in hot solutions (80° C) at low *p*H to form ammonium acid sulphate. Consequently the preparation of pure nickel sulfamate requires carefully controlled reaction techniques and the presence of suitable inhibitors to prevent hydrolysis. Because of the extreme lability of sulfamate salts to heat, it is virtually impossible to force crystallize or spray dry to produce a solid material which will not assay less than 98–99 per cent purity. Such a degree of purity is essential to operation of a sulfamate plating bath at full capabilities.

Pure nickel sulfamate (98–99 per cent) is supplied as a concentrated solution (48° Bé) or as a completely purified and ready-to-operate plating bath with all addition agents present in the proper concentration. Such concentrates made under laboratory control can be stored or operated indefinitely without excessive hydrolysis. A laboratory analysis conducted upon one nickel sulfamate plating bath, which had been in constant daily operation for five years, showed less than 1 per cent build up of ammonium acid sulphate.

There is strong evidence to indicate that the sulfamate ion has a tendency to complex metal ions in solution, and it is definitely known that it will form complexes with the sulphate ion,[21] which interfere with the usual analytical procedure for sulphate by barium precipitation. In a like manner, the conventional Kjeldahl method of analysis for ammonia (ammonium ion) is interfered with by the combined nitrogen in the amide group of the sulfamate ion. Other than conventional analytical techniques must be used therefore to determine with accuracy the degree of hydrolysis of any sulfamate solution.

Acidic sulfamate salt solutions can be buffered quite well with several of the weak acids such as boric, formic, acetic, citric, lactic, and tartaric. For purposes of nickel plating bath formulation, it is preferred to use the usual concentration of boric acid as an adequate buffer, in the operating *p*H range of 3.5–4.5 (electrometric).

Sulfamic acid is relatively non-toxic and non-fuming and upon brief contacts with the skin shows no noticeable effect. Sulfamate nickel plating baths are odorless and have no more noticeable effect upon producing skin irritations than do other nickel plating bath formulations of the Watts type. Sulfamic acid is not as corrosive in general to surrounding equipment as either fluoboric or hydrochloric acids.

The basic solution composition for a general purpose sulfamate nickel plating bath which will deposit nickel of medium hardness (250–350 VHN) at low internal stress is shown in Table II.

The basic solution as given may be prepared from available concentrates of nickel sulfamate by dilution to proper concentration and subsequent purification by the usual high *p*H and peroxide treatment to remove iron, followed by conventional carbon treatment, filtra-

TABLE I. SOLUBILITY OF INORGANIC SULFAMATE SALTS
GRAMS SALT PER 100 GRAMS WATER AT 25° C.

| | Sulfamate | Nitrate | Acetate | Chloride | Sulfate |
|---|---|---|---|---|---|
| Ammonium | 193 | 214.2 | 234 | 39.3 | 76.7 |
| Sodium | 106 | 91 | 50 | 36 | 28 |
| Magnesium | 119 | 75.4 | 65.5 | 56.7 | 26.9 |
| Calcium | 67 | 138 | 34.2 | 90 | 0.208 |
| Barium | 34.2 | 10.4 | 77.3 | 37 | 0.00026 |
| Zinc | 115 | 126 | 44.5 | 425 | 57.9 |
| Lead | 218 | 58 | 55 | 1.08 | 0.004 |

tion, and low current density electrolytic "dummying" to remove copper, zinc, and other metallics. The wetting agent and boric acid are then added and *p*H is adjusted to correct range with careful additions of sulfamic acid. The basic solution is also available as a completely mixed, purified, and ready-to-operate plating bath which constitutes a most convenient and reliable method of starting up a new bath.

The ranges of operating conditions of the basic solution are as follows:

| | |
|---|---|
| Temperature range | 100–140° F |
| *p*H range (colormetric) | 3.0–5.0 |
| Density (Baumé) | 29–31 |
| Anodes | 99 per cent plus, rolled depolarized |
| Maximum cathode current density | 300 asf at 140° F<br>150 asf at 100° F |
| Agitation | Cathode bar movement or solution circulation |
| Tank voltage | 6–9 volts |
| Anode efficiency | 100 per cent |
| Cathode efficiency | 98–100 per cent |

The average physical properties of nickel deposit from the basic solution are:

| | |
|---|---|
| Hardness | 250–350 VHN |
| Elongation in 2" | 20–30 per cent |
| Tensile strength | 90,000 psi |
| Internal stress (tensile) | 500 psi |
| Color of deposit | White |
| Appearance of deposit | Semi-matte to lustrous |

With slight modifications of both solution composition and/or operating conditions, plus the use of recommended addition agents, the basic sulfamate nickel bath can be adjusted to meet many special requirements of deposits which physical properties demand. Hardness may be increased to 550 VHN, stress can be controlled in the compressive range, tensile strength can be increased, appearance can be semi-bright to full bright and the deposit can have high levelling characteristics for easy buffing.

The sulfamate nickel plating bath possesses pronounced characteristic advantages over other conventional nickel plating solutions, some of which are of such importance to be made the subject of expanded discussion in this paper. Advantages are tabulated as follows:

1. Stress-free deposits (compressive stress deposits easily by the use of stable addition agents).
2. High current density operation at lower temperatures.
3. Simplicity of bath composition, control, and maintenance.
4. Low sensitivity to impurities.
5. Nickel deposits of high chemical purity.
6. Wide latitude of operating conditions.
7. Wide range of easily reproducible physical properties of deposit.
8. Improvement to fatigue strength of underlying base metal.

TABLE II. BASIC SULFAMATE NICKEL BATH COMPOSITION TYPE SN

| | | |
|---|---|---|
| Nickel sulfamate | 60 | oz/gal |
| Nickel metal content | 10.2 | oz/gal |
| Boric acid | 4 | oz/gal |
| Anti-pit agent | 0.05 | oz/gal |

9. Excellent grain structure and ductility.
10. High levelling action for easy buffing.

Control and maintenance has been reduced to a minimum in the sulfamate nickel plating bath. Because of the simplicity of the bath composition, in which the sole nickel salt comprises more than 90 per cent of the dissolved solids, routine analysis need be no more complicated than the taking of a hydrometer reading. The accompanying chart (Fig. 2) indicates the relationship between specific gravity or degrees Baumé at 70° F and nickel metal concentration at specified boric acid content.

Boric acid control is not critical and it is sufficient to analyze for this constituent only at monthly intervals, using standard analytical methods for the determination of boric acid. The *p*H should be checked periodically, preferably daily, with any good color comparator or electric *p*H meter. In normal operation, *p*H tends to rise slowly with use and may be adjusted quickly with small additions of sulfamic acid.

The sulfamate nickel plating bath has a very low sensitivity to contamination, in many instances tolerating much higher amounts of metallic and organic impurities than other conventional nickel plating baths. Good engineering practice is to provide for solution circulation with continuous electrolytic purification at low current density either in compartmented tanks or separate cells, in lieu of which to "dummy" periodically during shut-down time. In applications involving

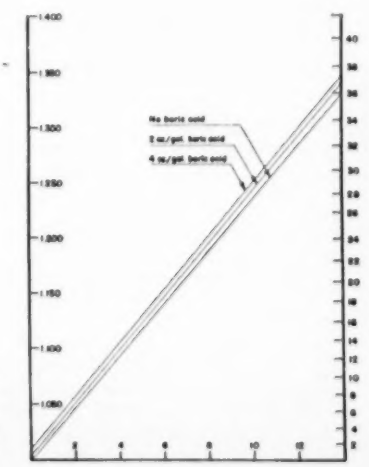

*Fig. 2. Relationship between nickel concentration in the sulfamate bath and specific gravity*

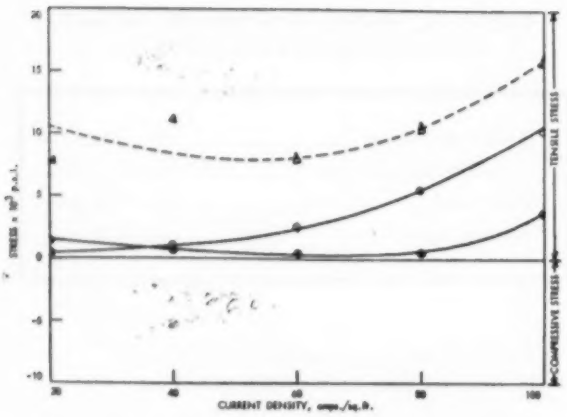


*Fig. 3. Effect of current density upon stress of deposits from the type SN sulfamate nickel bath. Symbol ● Type SN bath at 140° F; symbol ○ Type SN bath at 100° F; symbol △ Sulfamate-chloride bath, no addition agent, at 100° F*

extra heavy deposits, continuous filtration is advised. Activated carbon should not be used as it will remove the organic wetting agent or stress reducer (SNSR). Severe cases of organic pollution can be removed by the usual activated carbon treatment along with subsequent replenishment of the addition agents removed.

Sulfamate nickel plating solutions can be used with any equipment normally used with high chloride Watts' nickel solutions, providing however that lead be excluded from contact with the solution. Lead sulfamate is very soluble, and lead must not, therefore, be used for heating coils and thermostat control bulbs.

Anodes must be of 99 per cent plus purity and rolled depolarized or electrolytic sheet and should be bagged, preferably with Vinyon type bags. Anode corrosion is

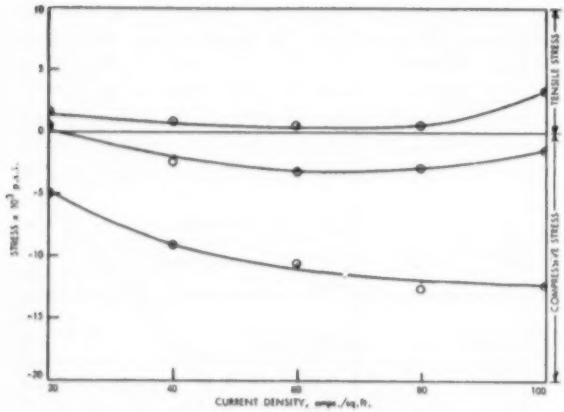


*Fig. 4. Effect of the addition of a stress reducer (SNSR) and the current density on stress of deposits plated from the sulfamate nickel bath at 140° F and a pH of 4.0. Top curve, no stress reducer; center curve, 0.5 fl oz/gal SNSR; bottom curve, 2 fl oz/gal SNSR*

100 per cent without the need for chloride ion to promote corrosion. Although other investigators of nickel sulfamate plating solutions have advocated use of chlorides in their bath composition, it is considered highly undesirable because chlorides promote excessively stressed deposits.

### Stress and Its Control

Many industries in recent years have used electroplating processes as engineering tools to solve production problems rather than merely as a means to obtaining a decorative finish. A few examples are: electroforming of complicated shapes (wave guides); salvage of worn or mis-machined parts by heavy build-up of deposits; hard cladding of soft metals for abrasion resistance; manufacture of phonograph record stampers and printing plates; reproduction of surfaces such as human skin texture in prosthetics for artificial limbs and for grain of simulated leathers; electroforming of denture models; production of finely perforated screen cloth; heavy cladding of pipe, chemical reaction vessels, and storage tanks. The literature is replete with references to such engineered applications of heavy nickel plating.

It has been common knowledge for years that in general nickel deposits have been plagued with high values of internal tensile stress which have been recorded as much as 60,000 psi from all chloride and high chloride Watts' baths.

Many authors have discussed in detail the importance of stress effects upon the quality of electroplating and within recent years have described several instruments for accurately measuring the stress of a deposit.[22, 23, 24, 25, 26] Excessively high stresses can cause peeling, cracking, crazing, warping, blistering, distortion, shrinkage, and even complete destruction and failure of plated metals either as structural units or as protective coatings.

Not only do highly tensile stressed plated coatings fail within themselves, but they also induce premature fatigue failure of the underlying base metal upon which they are laid down. The aspects of fatigue failure caused by electroplating has become a major problem with the aircraft industry where premature failures cannot be tolerated at any cost. These same stresses can also lead to the phenomenon known as "stress corrosion" which accelerates corrosion failures of many articles having decorative plate such as automobile bumpers and bumper guards.

Early in 1947 the author initiated research to discover a nickel plating bath which might produce nickel deposits low in stress without the use of certain organic addition agents. Hundreds of stress measurements were made on over 1,000 different nickel plating baths during a two-year period. The only bath which showed a pronounced decrease in stress of all those tested was the basic sulfamate nickel formula.

Plotted curves showing the relation of stress to current density are shown in accompanying graphs (Figs. 3, 4 and 5) and indicate the true stress of de-

posits made both from the basic sulfamate nickel bath as well as baths containing organic stress reducing agents (SNSR). The dashed line curve in Fig. 3 is replotted from data given by Diggin[20] and is included for purposes of comparing sulfamate baths operating with chlorides as opposed to those without chlorides.

All stress measurements were made with a Brenner-Senderoff Spiral Contractometer, an instrument admirably suited to accurate checking upon values of stress in plated coatings and which has been thoroughly described previously.[27] Because stress varies with thickness, all measurements were taken at the uniform plated thickness of 0.0006 inch as determined by ampere minutes of plating time and checked for accuracy periodically with Magnegage readings.

Variations in temperature, *p*H, and nickel metal content of the bath caused corresponding variations in recorded stress values. Except for the extremes of minimum and maximum, the stress variations were insignificant or within the experimental error of measurement.

In general the effects of all of the bath variables upon stress can be summarized in the following manner:

| | |
|---|---|
| *p*H | Stress has slight minimum at *p*H 4.0. Increases slowly at lower *p*H values and sharply at values above 6.0. |
| Metal content | No appreciable effect upon stress. |
| Temperature | Stress decreases with increase of bath temperature and increases with drop in temperature, usually not more than a total of plus or minus 5,000 psi for the extremes. |
| Chlorides | Stress rises sharply and linearly with increasing chloride content; approximately 3,000 psi for each 10 per cent increase of chloride as nickel chloride. |
| Current density | Stress increases gradually with increase of current density. |
| Agitation | Agitation reduces the rate of increase of stress with increase of current density. |
| Boric acid | No appreciable effect upon stress within the range of 2.0–5.0 oz/gal. |
| Wetting agent | Acts slightly as stress reducer. |

In those applications where deposits having specified stress values must be maintained under close production control, it is strongly recommended that some type of stress measuring instrument such as the spiral contractometer be used daily. The use of such an instrument for daily control purposes becomes quite simple once a specific helix has been calibrated in arbitrary units for the particular control range. It is not even necessary to strike the helix in Wood's nickel or copper plate in those instances where it is used to measure comprehensive stress as the nickel will not exfoliate from the stainless steel.

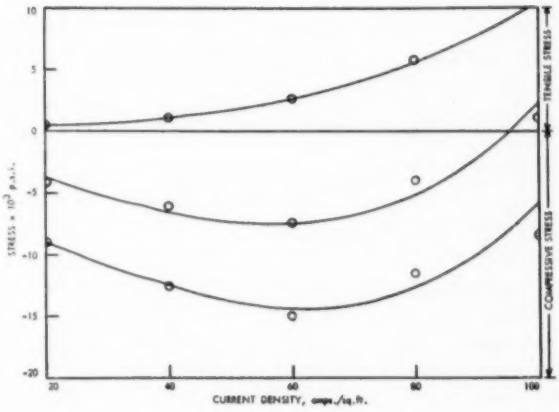


*Fig. 5. Effect of the addition of a stress reducer (SNSR) and the current density on the stress of deposits plated from the sulfamate nickel bath at 100° F and a pH of 4.0. Top curve, no stress reducer; center curve, 0.5 fl oz/gal SNSR; bottom curve, 2 fl oz/gal SNSR*

The stress reducer (SNSR) used in the sulfamate nickel bath to produce compressive stressed deposits is completely stable over long periods of bath operation and is lost only gradually through drag-out and co-deposition. There being no chemical analytical control for this material, it is necessary to control the effects of this addition agent with a stress measuring instrument.

### High Current Density Operation at Low Temperature

In certain types of electroforming operations, it is necessary to plate upon temperature sensitive materials such as wax, plastic, and low fusing point alloys, and in most cases the base material must be removed later by melting out, preferably in hot water or hot oil.

Heretofore, nickel plating bath formulae suitable for plating at room temperatures and having reasonably good stress characteristics have been those containing ammonium salts and, because of high *p*H operation, have been limited to current densities usually under 15 asf.

The sulfamate nickel bath can be successfully used at maximum current densities of 60–75 asf at temperatures ranging from 80–100° F, giving approximately a fourfold or better increase in speed. Previously cited references[16, 17, 18, 19] have indicated how this higher speed at low temperatures helped immeasurably to correct production bottlenecks in the electrotyping industry.

Additionally, it is well known that hardness of nickel deposits increase with decreased bath operating temperature. Sulfamate nickel baths can be operated as hard nickel baths at 90–100° F with but a slight sacrifice in limiting current density.

### Improvement of Fatigue Strength of Underlying Base Metal

It has been demonstrated that plated coatings of

tensile stress cause premature fatigue failures in the base metals upon the plated coating's failure from stress cracking.[28,29] Since the majority of fatigue failures originate at the surface, any weakness of a surface condition can be detrimental to life under fatigue conditions.

The aircraft industry in particular is very concerned with effects of plated coatings upon reduction of fatigue strength of steel and aluminum alloys.

Unpublished data have indicated that Watts nickel plating baths giving deposits with high tensile stress can cause as much as 46 per cent reduction in fatigue strength of underlying steel, whereas nickel deposited in compression causes no reduction and in some instances slight (5–7 per cent) gains in fatigue strength.

Almen,[29] has shown conclusively that fatigue fractures cannot originate and cracks cannot propagate in compressively stressed material and that tensile-stressed surfaces as thin as 0.0003 inch can be seriously considered a threat to early failure of a part.

Sulfamate nickel plating has been tested thoroughly over a period of two years by two major aircraft engine producers and has been found acceptable for plating parts without endangering their fatigue resistance. In certain cases, heavy nickel plate under compression has been used to increase materially fatigue life by protection of surfaces from nicks, scratches, or dents which might rapidly lead to fatigue failure. Two examples of such application is protection of the leading edges of propellor blades and jet engine compressor blades from small stone abrasions with heavy cladding of hard nickel under 2,500–8,000 psi compressive stress.

## Physical Properties

Deposits from sulfamate nickel plating baths have in general a very fine grain structure, and as a result the deposits are very smooth and ductile and have a slight sheen in appearance. The color is much whiter than any deposits from baths containing chlorides and indicates a higher purity of nickel without chlorine inclusion.

Tensile strengths range from 60,000 psi to 130,000 psi, depending upon the conditions under which a bath is operated. Correspondingly, ductility ranges from 30 per cent elongation in 2 inches to a low of 6 per cent elongation at a hardness of 550 VHN.

Hardness can be controlled in the range of 200 VHN to 550 VHN with reproducibility by use of recommended addition agents and shifting of operating conditions. High *p*H and low temperature operation of the basic bath will produce the hardest deposits without appreciable stress.

A complete résumé with collected data will be made the subject of a later paper upon the physical properties of sulfamate nickel deposits.

Sulfamate nickel deposited under compressive stress and with certain addition agents will have very good levelling power. Brush surface analyzer measurements have indicated a reduction in surface roughness from 120 microinches RMS to 7 microinches RMS for a deposit 0.0015 inches thick. The need to buff this smooth, relatively hard nickel coating is reduced considerably by such levelling action.


## Acknowledgments

In conclusion, the author wishes to acknowledge and thank the many people who have helped to contribute some of the data used in this paper: Mr. Earl Brodhag and Mr. Robert Ruddock for tensile strength, elongation, and other physical property measurements; Mr. I. Friedman of Curtiss-Wright Aeronautical for stress data; Mr. Moeller of Pratt & Whitney aircraft for fatigue measurements; and the E. I. DuPont de Nemours & Co. for use of their charts and data on sulfamic acid.


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MR. EDWIN R. BOWERMAN (Sylvania Electric Products, Flushing, N. Y.): Can electroformed printing plates be prepared consistently that have a hardness of 625 Vickers plus or minus 50? If so, what modification of bath would be required?

MR. BARRETT: 625 Vickers is a little high. We can consistently hold 550 to 575 Vickers. The modifications necessary to achieve that hardness are the use of an organic addition agent that is perfectly stable and a change in the operating conditions. We generally shift to a high *p*H operating range and low temperature.

MR. ARMAND G. CHARRON (Texas Instruments, Inc., Dallas, Texas): In plating aluminum parts, do you put this sulfamate nickel over the aluminum or is the conventional method of plating aluminum used?

MR. BARRETT: We use the conventional method of plating, using a zincate treatment. We do know of one particular job, preparing plates for selenium rectifiers, where laying sulfamate nickel directly on aluminum without zincate is used.

MR. CHARRON: Do you think you could also use this one-step method when either vapor blast or mechanical blast is employed?

MR. BARRETT: In the particular case mentioned, a vapor or mechanical blast is used. The interlocking surface condition helps to keep the nickel in place as well as the compressive stress of the nickel which makes it lay down as well.

MR. CHARRON: Do you feel it is sufficient?

MR. BARRETT: It is, in this particular case, but that is only a thin coating. I would not recommend it for thick coatings.

MR. A. D. SQUITERO (Hanson-Van Winkle-Munning Company, Matawan, N. J.): Was the chloride curve, shown by the dotted line, primarily on the tensile side?

MR. BARRETT: Yes.

MR. SQUITERO: Then you feel that the additions of chloride will always produce a deposit tensile in stress?

MR. BARRETT: Very definitely.

MR. SQUITERO: Can your process continuously produce a deposit in compressive stress in the presence of chlorides?

MR. BARRETT: Only in the presence of organic addition agents. Without their presence, tensile stress increases about 3000 psi for each 10 per cent increase of chloride content.

MR. SQUITERO: What are your objections to the use of chlorides?

MR. BARRETT: Chlorides raise the tensile stress of nickel deposits in direct proportion to their concentration. This is approximately 3000 psi for each 10 per cent increase of chloride as nickel chloride.

MR. SIDNEY WEISMAN (Curtiss Wright Corporation, Caldwell, N. J.): You showed a slide near the end of your lecture on the application of nickel to aluminum inducer blades. A great many requests have been made by our engineering department to use various types of coatings on aluminum and magnesium in order to reduce wear on certain parts in our propeller assemblies.

In contacting men who were influential in developing and applying the methods for plating magnesium and aluminum, recommendations were made that thick coatings of chromium or nickel should not be plated on parts used in high stress applications. You mentioned that there was an application of approximately 0.015 inch of nickel, which is a relatively thick coating. We have been reluctant to suggest the plating of thick nickel or chromium coatings on some of our aluminum or magnesium parts for the reason that we have experienced chipping and plating separation from parts subjected to operation under conditions of stress. I would like to have your opinion on this point.

MR. BARRETT: If nickel is laid down in compressive stress, a crack can neither originate nor propagate in the compressive surface. That is an established fact. To protect the sensitive surfaces of some metals like aluminum, the aircraft industry is now using fairly thick, hard nickel coatings. In fact, one aircraft company has put as much as 0.030 inch of hard nickel on the leading edge of propeller blades and have increased the life span of those blades from 100 to 400 hours.

MR. WEISMAN: Is it true that the basic preparation of the aluminum or the magnesium will represent the final adherence factor? In other words, if you have a zinc immersion method for preparing your metals, is it true that the final strength will be governed by the strength of that particular intermediate coating?

MR. BARRETT: Yes, that would definitely determine final adherence. Parts are bake tested in an oven for an hour at approximately 250° to determine adherence.

MR. WEISMAN: Have you had any experience in the use of sulfamic acid in the plating of titanium?

MR. BARRETT: No.

MR. A. ADAMS (Armalite Company, Ltd., Toronto, Ontario, Canada): Most patents now in effect on bright nickel solutions mention their use in sulfamate nickel solutions. Have you tried any of the major brighteners in your sulfamate solution? If so, how did the results compare to Watts type bright nickel solution?

MR, BARRETT: Our laboratory has developed a bright nickel sulfamate bath with compressive stress that will be announced very soon. It is more stable than a Watts type solution.

# AN ELECTROCHEMICAL METHOD FOR EVALUATING PLATED COATINGS*

BY W. J. PIERCE† AND W. L. PINNER†

## Introduction

In the plating industry there has been a long and unsuccessful search for a positive means of evaluating electrodeposits with respect to their corrosion resistance. There have been no accelerated corrosion tests reported in the literature that can be relied upon to predict service life of plated parts. There are two reasons for the failure of the many suggested tests to predict service life. First, the corrosive action of such tests has not been explained in most cases. Second, tests has not been explained in most cases. Secondly, if the action of the test method has been described it has not been demonstrated that a similar corrosive agent is the cause of service failure.

The authors recognize clearly the damaging effects of manufacturing procedures such as base metal polishing and numerous other factors which enter into the preparation of the base metal prior to the actual plating operation. In this regard, it has been shown[1] that base metal preparation can result in pores as a result of fragmented metal which lies underneath the plate and which may extend through the plate. It has also been demonstrated that certain faulty or inadequate metal cleaning procedures promote porosity in plated coatings.

The authors also recognize that porosity, or other potential sources of deterioration, in plated coatings may result from faulty manipulations in the plating operation itself, or from the use of plating baths which may not be in proper condition as a result of the presence of either dissolved or undissolved contaminating material. But it has not been demonstrated satisfactorily that such plate flaws, as for example porosity, are predominant factors in service failure. This is particularly true with respect to plates of substantial thickness, i.e., 0.001 inch and over. It is now believed that many service failures of plated parts cannot be assigned to existing porosity of the plate, or to any of the recognized defects found in electrodeposits which may be the result of poor manufacturing practice.

No current test procedures involving accelerated corrosion tests of noble metal plates yield results and data that can dependably be used to evaluate a plating process. Quantitative data that can be analyzed and applied to the study of the variables contributing to the corrosion resistance of an electrodeposit cannot be obtained from such tests as the salt spray. For this reason it has been difficult to improve the corrosion resistance of electrodeposits on the basis of results from ferroxyl tests, hot water baths, salt spray tests, and the like. Service tests, because of their long duration, are inadequate in assigning the causes of plate failures that are the result of manufacturing variables.

Because of the aforementioned shortcomings of present test methods, this study was initiated to discover a technic that would:

1. Disclose the points of potential plate failure.
2. Indicate the fundamental nature of the service corrosion of a noble metal electrodeposit.
3. Yield data that could be used in research to improve the quality of such electrodeposits.

## Method

At the beginning of the study it was felt necessary to reexamine a number of the methods for evaluating plates that have appeared in the literature. Many of these are based on the assumption that noble metal plates are porous, i.e., they have holes extending from the base metal to or near the surface of the plate. This assumption was demonstrated to be true for thin nickel plates (less than 0.0001 inch) by Shome and Evans.[2] These investigators formed a cell consisting of a copper electrode, a thinly nickel plated steel electrode, and a sodium chloride electrolyte. When this cell, shown in Fig. 1, was operated for some time, examination disclosed the presence of iron, but no nickel, in solution. This was taken as evidence that the plate was porous. The failure of the Evans cell to disclose pores in thicker plates did not seem to be explained logically in terms of prevention of diffusion of electrolyte by capillarity or other physical phenomena. Therefore, experiments were begun in order to find the reason for this failure.

The potential generated by a Shome and Evans cell was measured and found to reach a steady value of approximately 0.2 volt. When this cell technic was applied to bare steel panels, the developed potential

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, July 13, 1954.

†Process Development Division, Houdaille-Hershey Corporation, Detroit, Michigan.

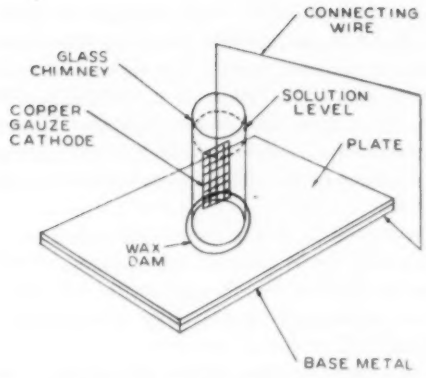


*Fig. 1. Shome and Evans cell*

was found to start at 0.3 volt and increase with time to a value of 0.38 volt. Figure 2 shows the variations of potential with time for the two cell systems. It was believed that the lack of sensitivity of the Shome and Evans cell, when applied to thicker deposits, was due to the lower potentials produced. To increase the potential of the test cell it was connected in series with a second cell containing a bare steel anode (Fig. 3). This resulted in increasing the test cell voltage to that of an iron-copper primary cell. This cell combination caused preferential attack which resulted in a perforation of deposits of substantial thicknesses (more than 0.0001 inch). Because of fluctuations in the iron primary cell, it was replaced by a battery powered potential source. The paraffin cemented glass cylinders of the original Shome and Evans cell were replaced with 3 x 4 inch Lucite chambers, equipped with a watertight gasket and clamping device. The original test apparatus, with some accessory equipment, is shown in Fig. 4. This equipment was used to evaluate the test variables. To determine the effect of the magnitude of the impressed voltage, a number of experiments were run at different potentials. These tests showed that general anodic solution of nickel did not occur below an impressed potential of 0.4 volt. A potential of 0.3 volt was finally selected for general test purposes. At this voltage the amount of nickel dissolved in each test seldom exceeded 50 micrograms and there was no danger of anodic attack on the plate. On the other hand, this potential was found great enough to insure consistent test results.

Many variations in electrolyte composition and concentration were tried without measurable affect on test results. Active chemical agents capable of causing solution of metallic nickel were avoided. A 3 per cent sodium chloride solution was found to be a convenient electrolyte, although saturated solutions of potassium chloride were used when making potential measurements with the calomel half cell.

Because of the impression of potential from an external source, the size and composition of the cathode was found to be of little influence. Copper wire was selected as a convenient material. Shape and place-

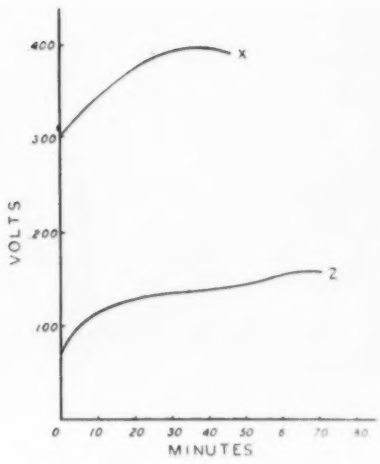


*Fig. 2. Potential variation for the two cell systems. X = bare steel panel, open circuit; Z = nickel plate over steel (0.0001 inch), open circuit*

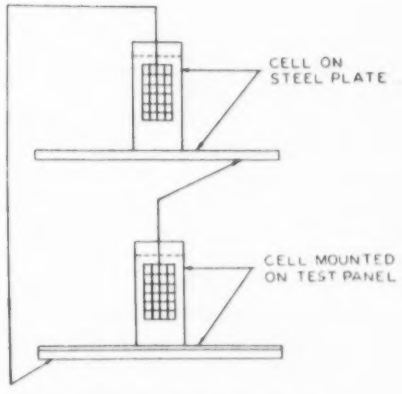


*Fig. 3. Modified test cell*

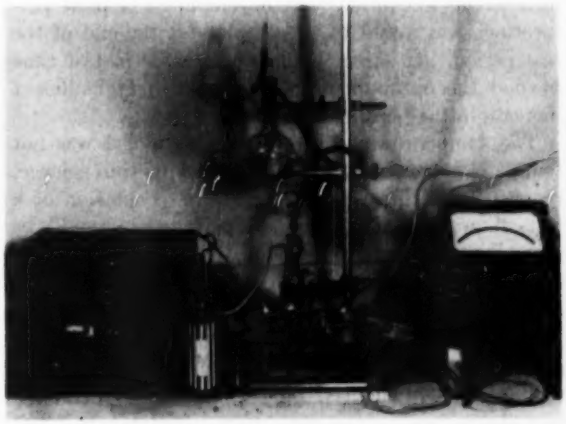

*Fig. 4. Original battery powered test cell and accessory equipment*

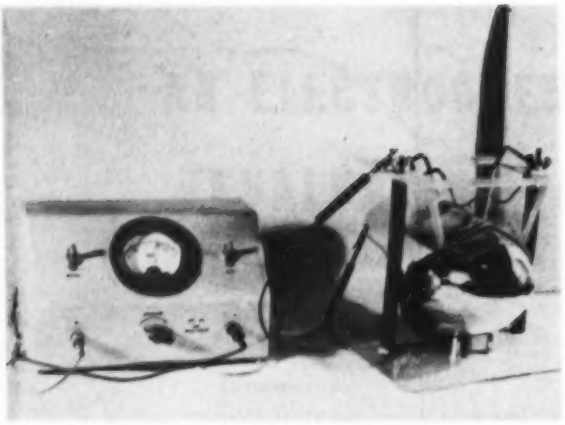

*Fig. 5. Modified test cell for use on production part*

ment of the cathode proved to have no effect on the perforation pattern of the nickel plate.

It was found that the test area was best kept at 12 square inches. In large areas secondary cells developed over the surface of the test plate. This was considered evidence that the test method was very closely related to natural corrosive phenomena and did not exceed in intensity the local potentials produced by oxygen induced galvanic cells.

Surface cleanliness, wetting, and air bubbles were found to be of little consequence. Ionic wetting agents in the electrolyte migrate to the electrodes and polarize them, destroying the efficiency of the test. Chromium plating slowed the testing greatly. Test plates were either not chrome-plated or were stripped of chromium with hydrochloric acid if necessary. This had no effect on the number of perforations developed in the nickel.

The time needed for a test was found to vary with the thickness and type of deposit. The thicker plates required more time to develop a constant number of perforations than thin deposits. The actual time used was determined for each plate system studied. Normally this time is two or four hours for deposits of commercial thickness. The development of plate perforations was found to be complete at the end of the test period. In other words, an increase in test time beyond the optimum does not result in a significant increase in the number of holes developed.

The temperature of the cell during a test was not found to be critical and, as a matter of convenience, room temperature was used. At the conclusion of a test, it was found that small perforations could be more easily located by quickly washing the test piece with dilute solution of potassium ferricyanide, which caused exposed iron to develop a typical blue color.

After the above manipulations of variables were completed, along with the evaluation of some minor items such as gasket and cell materials, standards for test procedures and equipment were established. The equipment itself was simplified by removing the experimental measuring circuits. A simple battery powered potential source was designed so that the entire apparatus was portable. Figure 5 shows the simplified test equipment with a special cell for use on a production part. The following procedure was set up.

1. The electrolyte was standardized at a 3 per cent aqueous NaCl solution with Rochelle salt added in sufficient quantity to keep iron in solution during the test.
2. The test cell was given a normal area of 12 square inches, smaller cells to be used where necessary. Lucite was selected as the cell material. Two inches was found to be a convenient cell depth.
3. Gasket material was closed cell, sponge rubber, 1/4-inch thick.
4. Clamping devices for securing the Lucite cells to plated surfaces were insulated from the test specimen by means of sheets of dielectric materials.
5. The cathode selected was a cradle of heavy copper wire insulated from metal portions of the clamping device.
6. The direct current source was fixed at 0.3 volt output from a variac controlled rectifier or a portable battery operated power supply.
7. The test procedure itself consists of the steps listed below:
   a. The plated surface is locked in the clamping fixture with the test cell in place.
   b. The copper cathode is positioned in the Lucite cell and sufficient electrolyte is added to cover the cathode.
   c. Electrical connections are made to the plated object and the copper cradle. The plated surface is the anode, the copper wire the cathode; 0.3 volt is applied to the system for a period of two, four, or more hours as necessary, depending on the nature of the plate and its thickness.
   d. After the test period the plated surface is rinsed, and dried and the number and type of perforations determined. When testing a plated ferrous metal, if necessary, the surface is rinsed with ferricyanide solution to reveal the perforations more clearly.

## Results

The purpose of the electrolytic corrosion cell described above is to supply quantitative data, in terms of numbers of perforations per unit area, concerning the corrosion resistance of an electrodeposit. It may also reveal qualitative data regarding such things as plate inclusions or types of plate (bright, semi-bright, etc.) by means of distinctive forms of perforation.

In order to lead up to a discussion of how and why the corrosion cell works, it is best to describe some actual test data and observations. There are two types of observation (qualitative and quantitative) that the user of the corrosion cell can make. The form of perforation varies with the nature of a nickel plate; i.e., whether it is bright, semi-bright, or matte. Because of this, an experienced person can identify a plate type by

examining the perforations. Inclusions in the plate react in the corrosion cell in differing ways, depending on whether they are ferrous, nonferrous, or nonmetallic. The number and effect of such inclusions can be determined thereby. Above and beyond these things the number of actual perforations in the plate yields quantitative data that may be graphed or charted.

To describe an actual test, a bumper was given a corrosion cell test in two areas of 12 square inches at opposite ends of the bar. One end had a few perforations and the other a great many. The end with the few holes showed a mixture of ferrous and nonferrous inclusions. The test areas were stopped off and the bar was salt-sprayed. The section of the bar containing inclusions showed pinpoint corrosion, the other end rusted badly. Upon sectioning, the rusted end was found to be 10 per cent thinner in plate thickness than the balance of the bar. All this was predicted in advance on the basis of the corrosion cell data.

In the laboratory the corrosion cell was used in evaluating series of test panels to determine the number of perforations developed under varied metal finishing procedures. It was the experience gained in this type of analysis that enabled the accurate predictions described in the preceding paragraph to be made.

There are a number of manufacturing variables which have been established as influencing the corrosion resistance of plated coatings. It appears to be quite firmly established that the following factors are important:

1. Plate thickness.
2. Physical preparation of the base metal before plating.
3. Electrochemical preparation of the base metal before plating.
4. The manipulation of the plating bath itself.

The experimental work involved in evaluating the above factors consisted of series of tests for which hundreds of panels were prepared and tested.

*Effect of Plate Thickness and Electrochemical Preparation of the Base Metal*

As a matter of convenience these two factors were checked simultaneously. A considerable number of panels were plated with varying thicknesses of coatings from different types of nickel plating solutions. Coincident with the preparation of these panels, cleaning procedures were used which included or excluded anodic acid etching as a part of the cleaning cycle. Figure 6, a, b and c, pictures a tridimensional concept of hole numbers in nickel plate as affected by anodic etching. The results substantiate the claims made by one of the authors[1] and others as to the benefits secured by the use of this electrochemical treatment on steel which is to be plated. Figure 7 graphically portrays the corrosion cell test results on Watts nickel deposited over etched and unetched steel. Figure 8 charts the results of a similar test on a proprietary semi-bright nickel plate. Figure 9 shows the corrosion cell test results on a proprietary bright nickel plate. In the results shown

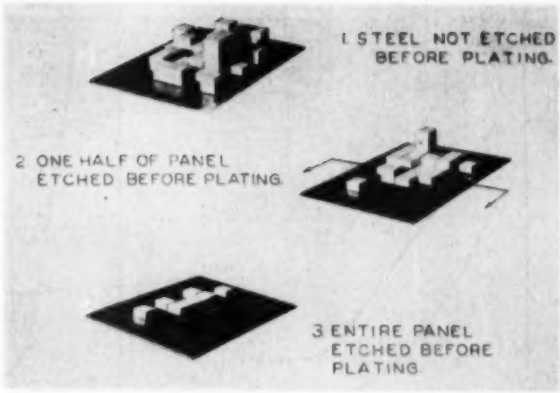


*Fig. 6. Effect of anodic etching on hole numbers of nickel plates, tridimensional*

in Fig. 9, the benefit of anodic etching on thinner bright plates, at least of the kind studied, is interesting. Bright plates of 0.001 inch or more did not show any significant improvement in corrosion resistance due to anodic etching. Figure 10 presents the relation between plate thickness on buffed and unbuffed panels as measured by the corrosion cell. While buffing reduces the total number of holes in the thinner plates, it is to be recorded that such holes, as occurred, were large in area, possibly reflecting buffing through or nearly buffing through the plate.

In further studies on the effect of anodic etching, Fig. 11 compares the number of perforations with the time or total ampere minutes of the operation. A current density of 150 asf was used in a standard sulfuric acid anodic etching solution. It will be noted that an improvement occurs up to a 30-sec etching time, but that at 45 sec the coating is apparently less protective than with any other time of treatment, after

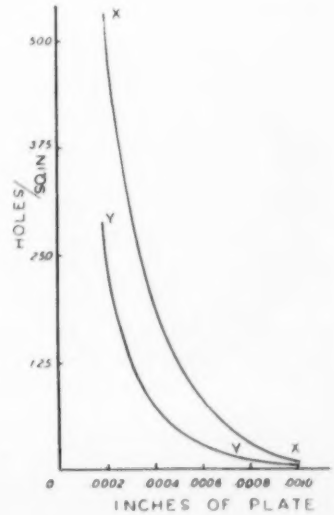


*Fig. 7. Corrosion cell test results on Watts nickel over cyanide copper on etched and unetched steel. X-X, unetched; Y-Y, etched at 100 asf for 30 sec in sulfuric acid*

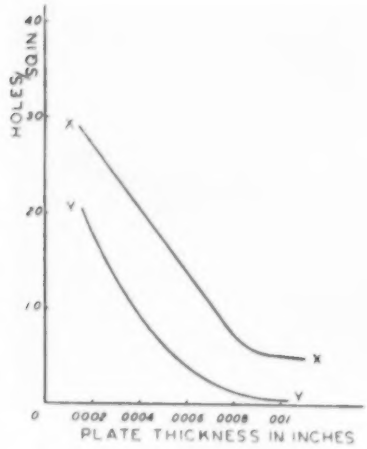


*Fig. 8. Corrosion cell test results on semibright (proprietary) nickel on steel. X-X, unetched; Y-Y, etched at 100 asf for 30 sec in sulfuric acid*

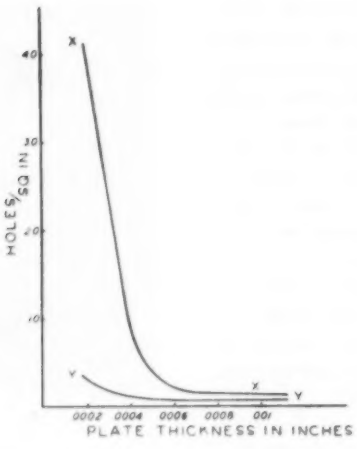


*Fig. 9. Corrosion cell test results on bright nickel on steel. X-X, unetched; Y-Y, etched at 100 asf for 30 sec in sulfuric acid*

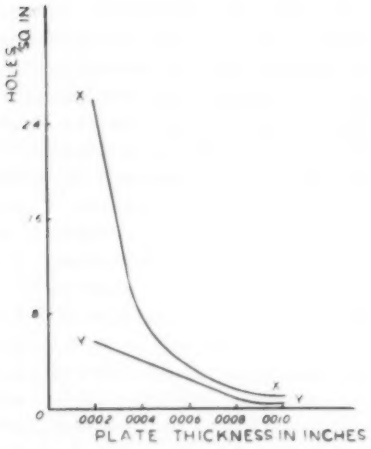


*Fig. 10 Relation between plate thickness and results measured by the corrosion cell. X-X, unbuffed; Y-Y, buffed deposits*

which marked improvement again occurs. Considering this data in the light of other investigations which the authors have carried out, it is believed that the initial improvement up to a 30-sec etching time occurs as the result of the removal of loosely attached steel slivers. During the next 15 sec it is believed that more firmly attached steel particles are disturbed but not detached and flaws in the steel surface are exposed, resulting in loss of corrosion resistance. Further etching time is thought, as previously shown by one of the authors,[1] to effect a more complete removal of metal debris and to assist the cleaning out of surface seams.

*Effect of the Physical Preparation of the Base Metal before Plating*

Many investigators have published the results of investigations of the effect of the physical preparation of steel on the subsequent quality of plated coatings. Sandblasted steel is notorious in producing metallic coatings having poor corrosion resistance, at least when applied in the range of decorative thicknesses. Furthermore, the same investigations have revealed that plate applied on a rough polished surface and subsequently buffed was found to be inferior to that applied on better polished metal. Plate applied on cold rolled steel which has received no polish is known to have superior protective properties as compared with the same type of metallic coatings on polished steel.

Data from corrosion cell tests verify most previous work on the effect of base metal preparation on the corrosion resistance of commercial nickel electrodeposits. Nickel plate on sandblasted surfaces was found to develop hundreds of perforations. Plate on good, polished steel developed perhaps a dozen perforations as compared with 30 or more on poorly polished steel. A test of plate on cold rolled steel revealed the development of six or eight perforations in an area of about 12 square inches.

As a part of the investigation iron was electrodeposited over a highly buffed brass surface. When the brass was dissolved away from the electroformed iron, a surface was obtained which was smooth and unaffected by abrasion or other mechanical working. On this type of surface a decorative thickness of nickel plate was revealed by the corrosion cell to be quite superior in that it developed perforations of very minute size. As an interesting exhibit of the effect of polish, Fig. 12 is a photograph of a relatively thin plate tested in the corrosion cell and on which the perforations can be seen to follow polishing scratch lines.

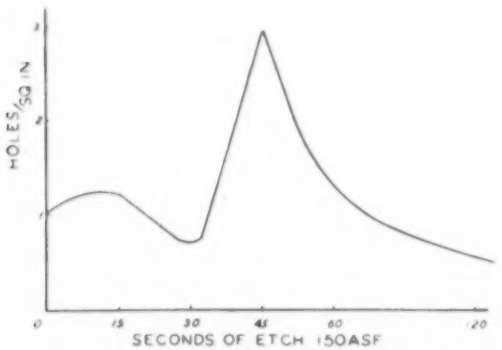


*Fig. 11. Relation between holes per square inch developed by the test and time of etching the steel in the sulfuric acid etching solution. Current density, 150 asf*

*Effect of the Manipulation of the Plating Bath Itself*

Work on evaluating nickel or copper-nickel deposits as a function of manipulation of the plating baths has not been comprehensively studied as yet. A rather complete program related to this phase of metal finishing is planned as it is felt that the plating bath itself is a potential source of improvement in plate quality. One

interesting study is portrayed in Fig. 13 showing the affect of organic addition agent concentration in a proprietary nickel plating solution. It appears from these results that amounts of addition agent, less than that specified as the optimum, not only result in imperfect working of the bath, but actually lower plate corrosion resistance.

In addition to the differences in perforation appearance caused by various proprietary plating solutions, the base metal may also affect their configuration. This is shown in Fig. 14, which is a photograph at 25 diameters of the type of perforation resulting from testing a semi-bright nickel plate on one of the low alloy, high tensile steels. Figure 15, at the same magnification, shows the character of the perforations on the same plate deposited on a special finished cold rolled steel. Figure 16 is a photograph at 500 diameters of one of the holes shown in Fig. 14. The photograph in Fig. 17 is a similar enlargement of one of the holes developed on the cold rolled steel surface.

As previously mentioned, the tests which have been described were made on hundreds of panels with consistent results. The general pattern indicates that there are a number of manufacturing variables, given little thought at the moment, which may be quite important to the maintenance of uniform corrosion resistance. Such factors include those of rinsing, transfer time, and proper timing of the actual chemical and electrochemical operations. These variables, it appears to the authors, are also evident in erratic service life of parts presumably finished to the same manufacturing standards.

Because it was felt that this test method was capable of evaluating true corrosion resistance of commercial plates, actual comparison of corrosion cell test results with service conditions was undertaken. For this purpose a large number of panels were produced in the preparation of which various factors related to the protective value of nickel plate were introduced. Following their preparation, the panels were divided into three

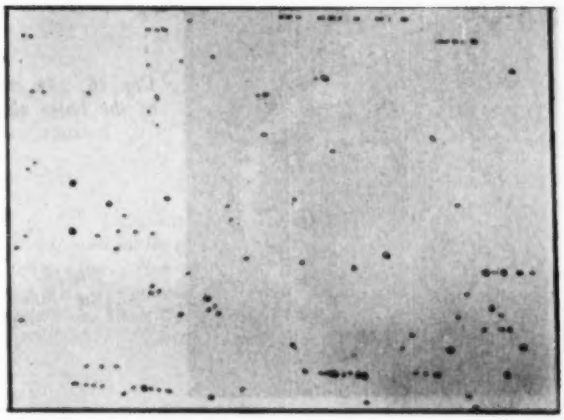

*Fig. 12. Thin nickel deposit after the corrosion test showing perforations that follow polishing scratch lines*

groups, one of which was placed on automobiles, as shown in Fig. 18. In this photograph there will be seen, in addition to the test panels, a collector bottle in which road soils encountered during this test were gathered and subsequently analyzed. A second group was allocated for salt spray testing and a third set was examined by means of the corrosion cell.

The panels placed on service exposure were driven an aggregate of 125,000 miles on automobiles in winter weather conditions, which favored the deterioration of plated coatings. At the conclusion of the three way test, the condition of the service parts was found to have been accurately predicted by the corrosion cell. As has been noted by others, the salt spray did not give results which could be interpreted in terms of expected resistance to corrosion under service conditions.

It was successfully demonstrated that a direct correlation exists between the number of perforations developed in the corrosion cell and the amount of rusting that occurs under service conditions. This allows quantitative and statistical treatment of data from

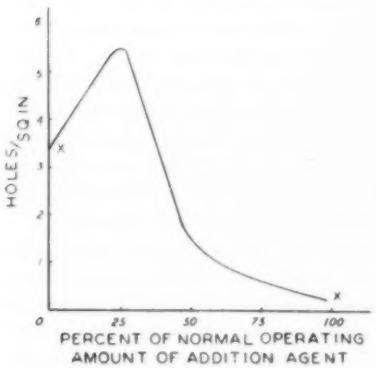


*Fig. 13. Effect of proprietary organic addition agent concentration as reflected in the corrosion of the nickel deposit. No anodic etch was used*

*Fig. 14. Type of perforation resulting when the test is applied to a semibright nickel over a low alloy, high tensile steel, magnification 9X*

*Fig. 15. Type of perforation resulting when a semibright nickel is deposited on a special finished cold rolled steel, magnification 9X*

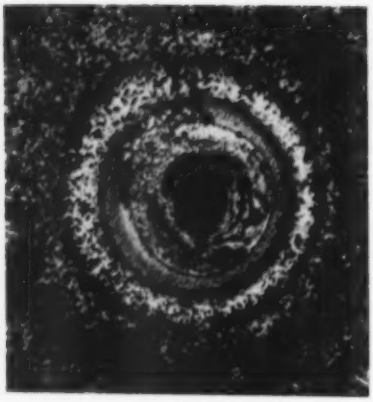

*Fig. 16. An enlargement of one of the holes shown in Fig. 14, magnification 150X*

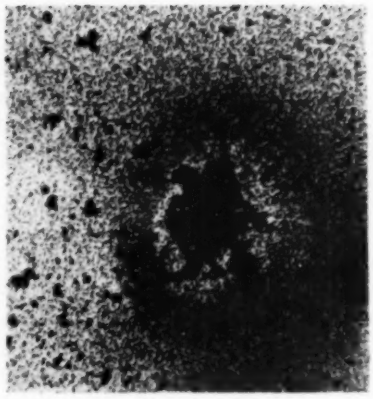

*Fig. 17. Enlargement of one of the holes shown in Fig. 15, magnification 150X*

corrosion cell tests. From these data, valid inferences concerning the quality level of a series of plates may be made in accordance with established statistical principles.

Because of these successes the corrosion cell tests were extended to combinations other than nickel plates on steel. Nickel on copper, copper on steel, nickel on magnesium, zinc and aluminum base die castings, and immersion nickels on steel were also subjected to the corrosion cell tests. From these data, valid inferences nickel on die castings the cell disclosed both perforations and blisters, an accurate reproduction of service failure.

After accumulating a store of data and experimental results sufficient confidence in the validity of the corrosion cell test was gained to allow investigation into the nature of its action on nickel plates and the reasons behind the appearance of the perforations.

### Application of Test Method

As originally conceived, this test was designed to furnish rapid and accurate information on the corrosion resistance of sample deposits produced in the laboratory. As a laboratory research tool, this test method has consistently met these requirements. In actual practice, it has been found desirable to apply this test to deposits that will show a significant amount of corrosion. This is necessary if the test is to furnish quantitative data. Deposits having a high degree of corrosion resistance will show, at the most, only a few points of attack in a four-hour test period. When this test is applied in such a way that a significant number of corrosion spots are obtained, the data are subject to normal statistical methods which will provide information on a quantitative level. This is another way of stating that this test is not only capable of distinguishing between good and bad plates, but is also capable of furnishing information that will indicate how good or how bad the deposit may be from a corrosion standpoint. This concept is particularly important when it is desired to introduce some physical or chemical variable to study its effect on plate corrosion. A plate thickness may be selected to produce the desired number of points of corrosion. This thickness may vary with different plating systems. Having decided upon the proper plate thickness for a given system, it is then relatively easy to determine the effect of any one controlled factor in the plating sequences.

*Fig. 18. Service exposure test of nickel plated panels*

Experimentation has shown that the quantitative results determined on a plate, having a thickness of 0.00075 inch for instance, may be extrapolated to predict corrosion resistance at greater thicknesses, i.e., 0.00125 inch. Used in this way the testing procedure will furnish valuable information on the effect of controlled variables, such as base metal preparation, preplate cleaning, physical manipulation of the plating process, and variables in the plating solution itself. By the application of standard statistical methods, the state of control of any plating system may be determined. In this way it is possible to evaluate physical and chemical factors that may be introduced into a plating system to bring it into a state of control.

This test method may also have potential value as a production tool. In cases where normal production deposits will provide a significant number of points of attack in a four-hour test period, the procedure may be used in the same way as in the laboratory. Applied in this way, the information obtained may be used to establish and maintain quality control standards. Another important use for this method would be to locate and correct changing variables in plating sequence.

In plating procedures where the normal deposit is

not capable of being perforated in a significant number of points due to thickness consideration or some other factor, the test may still be used as a "go and no-go" inspection technique. In this case any appreciable number of corrosion spots developed would be immediate evidence that some factor had upset the normal corrosion resistance level of the deposit.

### Instrumentation

The direct-current source used in the development of this test was a conventional 25-amp, 8-volt plating rectifier. Fine adjustment of the required cell voltage was obtained by the use of an autotransformer on the rectifier input. The test voltage was measured with a high resistance (20,000 ohms per volt) voltmeter or a potentiometer.

When the need for a portable power unit arose, the equipment shown in Fig. 5 was developed. A schematic diagram of this power source is shown in Fig. 19. The potential source is a 1.5-volt dry cell. The potentiometer "R" is a miniature 100-ohm, wire sound, radio control unit. A switch "S" in the battery circuit is used to apply the potential to the test cell. The voltmeter "V" is a rugged commercial instrument such as the Simpson Model 25 voltmeter and is calibrated for a 0 to 500 millivolt range. As these meters have a low internal resistance, a switch "S" is provided so that the meter may be removed from the test cell circuit after adjusting the test voltage. Greater accuracy may be obtained by the use of a more sensitive meter. However, tests have shown that this is not necessary for the proper application of the test method. The use of this compact, rugged power source makes it possible to apply the test in the shop or in any location where the use of more delicate instrumentation is not feasible.

### Theory

Nickel plates are not homogeneous. If a freshly plated and dried panel is slowly heated to 500°–600°F, visible exudations form on the plate. Subsequent corrosion cell testing shows a diminution in hole numbers. At 0.3 volt, solution of nickel in the corrosion cell cannot be direct anodic solution and yet there is a preferential attack at various points on the surface. Yet at thicknesses of 0.001 inch of nickel plate, no one has detected the existence of pores as such. The most direct conclusion to draw is that within an electrodeposit of nickel and other noble metals, there are points that are susceptible to electrolytic corrosion. These may logically be called *points of galvanic weakness.*

Points of galvanic weakness may have a number of causes and characteristics. They may be trapped water, electrolytes, stress areas between crystals, or differential alloying or compounding at crystal faces, to mention a few. They do have one common property. In the presence of an electrolyte they form galvanic cells. It is these cells that cause most service failures of plated parts, and it is these points of galvanic weakness that are exposed by the described corrosion cell as perforations in the plate.

If the existence of these points of galvanic weakness is granted, and the evidence contained in this paper strongly supports such a view, the corrosion resistance of an electrodeposit is dependent upon three things:

1. The chemical nature of the plate, or its nobility;
2. The finish of the base metal and the inclusion of foreign particles in the deposit;
3. The number of points of galvanic weakness.

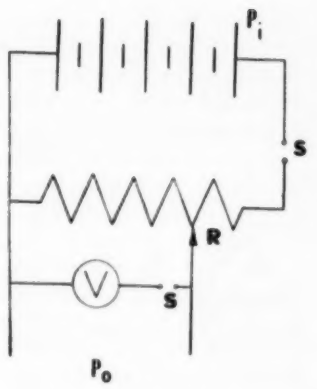


*Fig. 19. Diagram of circuit used for the corrosion test. $P_o$ = 1.5 dry cell; R, = potentiometer; S, switch; V, = voltmeter; $P_i$ = cell*

Items 1 and 2 are external factors, and item 3 is an inherent property of an electrodeposit depending on the cleaning cycle and the constitution or state of the plating bath. By means of the corrosion cell it is possible to determine the variables contributing to the points of galvanic weakness. When this is done it will be possible to control the quality of an electrodeposit in its entirety, something heretofore impossible. Item 1 is a matter of specification. Item 2 is a matter of good housekeeping and manufacturing practice. Item 3 is a whole new field opened to the research scientist in electroplating.

### Conclusion

In conclusion the authors feel that the corrosion cell embodies the goals they originally set out to achieve.

1. It is a rapid test for noble metal plates that reveals the relative merits of such plates under service conditions.
2. It yields quantitative data, in terms of hole numbers, that may be analyzed and treated statistically.
3. It yields qualitative data concerning roughness, inclusions, and erratic plate thickness.
4. And, most important, it sheds new light on the nature of service corrosion and failure and enables the plater to perform intelligent research directed toward improving the corrosion resistance of his product.

### Acknowledgment

Grateful acknowledgement is made to the Houdaille-Hershey Corporation for permission to publish the results of this research. The work was initiated as a necessary first step in a broader program designed to improve product quality. Such an effort required a valid measuring stick with which processing variables could be evaluated. The authors consider it a privilege to make this test method available for use by others,

with the hope that it may contribute to further research directed toward a greater understanding of the mechanism by which plated coatings fail. Such further knowledge should be important in contributing to better quality.


REFERENCES

[1]W. L. Pinner, A Further Study on the Effect of Abrasive Metal Polishing on the Character of Nickel Plate. Proc. Am. Electroplaters' Soc. **40**, 83 (1953).

[2]U. R. Evans and S. C. Shome, Studies in the Discontinuities in Electrodeposited Metallic Coatings. J. Electrodepositors Tech. Soc. **26**, 137, (1950).


## DISCUSSION

MR. A. T. PATTERSON (Patterson Plating, Toronto, Ontario, Canada): In doing your anodic etching, how do you keep the copper out of the bath? I would be concerned about the possibility of copper redepositing on the steel and causing poor adhesion. Do you use copper hooks?

MR. PIERCE: We do not use copper hooks in our operations, and there is otherwise no possibility for the introduction of that metal into the anodic etch solution. We employ steel hooks that are both mechanically and electrically built strong enough for the work.

MR. ERICH LAUE (MacDermid, Inc., Waterbury, Conn.): Did you correlate your tests with the pore test by gas permeability? Do you consider your centers of activity to be pores, either open pores or partially closed pores?

MR. PIERCE: We have not attempted to correlate our corrosion test results with porosity as measured by gas permeability. I doubt that any such correlation could be made. We do not regard the activity centers of our corrosion test to be pores in the deposit. As a result of our investigation, we believe that pores, i. e., open or partially closed channels to the base metal, do not exist in deposits of substantial thickness. The work carried out in AES Research Project No. 6 also indicated that pores do not exist, as such, in deposits of any considerable thickness.

By means of their cell technique, Shome and Evans apparently demonstrated the existence of porosity in thin deposits (less than 0.0001 inch). This conclusion is based on the fact that on completing a test considerable amounts of iron, but no nickel, were found in the electrolyte. After a test is completed, using the procedure outlined in our paper, small amounts of nickel are found in the electrolyte. It had previously been demonstrated that the applied potential used in these tests is insufficient to cause anodic solution of nickel. It is believed that local electropositive areas do exist in a deposit and that the application of a small potential will result in the selective attack at these localized points. We have called these areas points of galvanic weakness, and it is believed that these are the activity centers in our corrosion test.

MR. ROBERT J. MCKAY (Basking Ridge, N. J.): The oxygen concentration cell that is now well recognized as a major moving force in local corrosion can theoretically furnish local cell corrosion potentials strong enough to cause rapid damage. While theoretical potentials have not been reached in laboratory studies it is quite easy to obtain cell potentials up to about 0.4 volts, corresponding to the potentials used in this test, simply by varying the supply of air to two electrodes of exactly the same metal. The rate of corrosion that results depends more on the supply of air than on the actual metal or metal combinations that are used when dealing with such common alloys as steel, commercial nickel, copper, and stainless steel.

In other words, these cells are self-starting and under certain conditions are self-perpetuating. Much time and effort have been spent on the study of porosity under the assumption that porosity is the one major cause of premature coating failures and without success in demonstrating that there is a definite connection between the two phenomena. The operation of the described test was developed, according to Mr. Pinner, on the assumption that points of galvanic weakness may be present with or without measurable porosity. In view of the known activity of oxygen cells, this is a sounder view. Dr. W. A. Wesley in his paper, "The Weathering of Nickel-Chromium Electrodeposits," given before the recent Fourth International Conference on Electrodeposition, is in apparent agreement with Pinner in that he definitely accepts corrosion as the cause of failure rather than porosity alone.

Thus Pierce and Pinner seem to be on sound theoretical ground, and they have apparently demonstrated the practical value of the test, both of which points are doubtful with respect to the salt spray. My question is whether complete working instructions for equipment and operation of the test are now available for other laboratories and how can they be obtained?

MR. PINNER: We are very grateful to have Mr. McKay's remarks and to note his endorsement of the theoretical concepts underlying this test.

Replying to Mr. McKay's question, we hope that the published manuscript will adequately describe the equipment and working instructions for the operation of the test. The authors will, however, welcome any inquiries from interested people, in the event that further assistance may be necessary. In the verbal presentation of the paper it was stated that the authors had developed this test to the point that it was considered to be dependably useful as a research tool. It is recognized that many fundamental concepts need further clarification and it is hoped that other investigators may wish to carry out such work and that they may wish to explore more completely the utility of the test as it may be employed to evaluate various other types of plated coatings on various base metals.

# aes research project no. 14

# TAPER SECTIONING OF BASIS METAL SURFACES AND ELECTRODEPOSITS*

F. A. MOHRNHEIM† AND A. E. R. WESTMAN†

SUMMARY

*An improved method of taper sectioning is described that enables it to be reduced to a routine operation. The origin of the "palisade layer," observed in certain taper sections and referred to at the 1953 Convention, is established as the result of controlled etching experiments and an investigation of the flatness of taper sections by interferometry. A study, by taper sectioning, of the surface effects produced in low and high-carbon steels subjected to blasting by various abrasives is also described.*

## INTRODUCTION

A standard metallographic technique used in the study of metals is that of cross-sectioning where a specimen is cut perpendicularly to the surface and the revealed face is then observed under a microscope after suitable polishing and etching. As the useful magnification of an optical microscope extends up to 2000 and there is loss of definition at the upper limit, it is obvious that the method is limited for investigating fine irregularities in metal surfaces and the interface between basis metals and electrodeposits. It must be remembered that a surface showing irregularities of 10 μin or less, which is not uncommon in a cold-rolled steel, would require a magnification of about 10,000 for visual observation. However, these limitations may be overcome to a considerable extent by cutting a specimen at an oblique angle to the surface with a consequent magnification in the vertical direction of tenfold or more. This refined metallographic technique, known as taper sectioning, is not new but has had less application in the plating industry than its advantages would warrant. This is presumably due to the fact that the preparation of a specimen is time consuming and that few workshops possess facilities for the mounting and precision grinding of specimens at precise taper angles.

The use of taper sectioning for a metallographic study of surface contour was first described by Nelson.[1] Essentially, his method consisted of mounting a specimen on an accurately shaped wedge and grinding in a plane parallel to the base with a surface grinder until a suitable oblique section was revealed. The method has also been used for an inspection of ground surfaces[2,3] and a metallographic evaluation of surface coatings.[4] A detailed account of a taper-sectioning technique involving a different method of mounting the specimen has been given by Moore.[5]

Both Kellner[6] and the authors[7] have drawn the attention of electroplaters to the usefulness of taper sectioning as a tool for the investigation of surface smoothness. However, until this time, no simple technique has been described which would reduce the preparation of taper-sectioned specimens in a metallographic laboratory to a routine operation. A method, which is no more tedious than that of preparing a normal cross section and does not require the assistance of a competent machinist, is described in the following section.

## A SIMPLIFIED METHOD OF PREPARING TAPER SECTIONS

To preserve the surface of a specimen from distortion due to subsequent polishing, the practice of depositing a protective plating is generally recommended. For the study of the surface boundary between a basis metal and an electrodeposit, the specimen provides its own protection.

From a flat plated sample a square section of approximately 5/8 inch is cut and placed face downwards on the steel block of the metallographic mounting press (Fig. 1). To incline the specimen a support is placed under one end. Often a piece of the same sample from which the specimen was cut is suitable for this purpose. The thickness of the support and its distance from the lower edge of the specimen determine the vertical magnification of the face due to tapering. One of the difficulties experienced initially was that the support lost its hold during the grinding operation and was torn out of the Lucite mounting block. This pitfall was overcome by bending the support to an "L" shape in order to provide a solid anchorage in the embedding medium.

It was found that with soft or thin materials the specimen inclined on the support would often bend under the high pressure of the mounting press. This fault was corrected by backing the specimen with a thicker steel plate of approximately the same area. Pressure must be applied after the Lucite mounting powder is completely molten and then increased very slowly to the normal value, thus ensuring the flow of the mounting medium around the specimen without disturbing its original position. Bakelite may be used as an alternative material to Lucite for mounting, provided the mounting pressure is applied slowly.

Figure 1 shows the diagonal cross section A-A through the Lucite mounting block and the specimen in its suggested mounting position. During the subsequent grinding and polishing a sufficient thick-

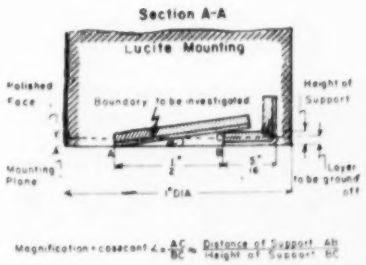


*Fig. 1. Diagram of a cross section through a plated sample mounted for taper sectioning in a metallographic mounting block*

*Presented at the Forty-First Annual Convention of the American Electroplaters' Society, July 13, 1954.

†Research Fellow and Project Director, Respectively, AES Research Project No. 14, Department of Chemistry, Ontario Research Foundation, Toronto, Canada.

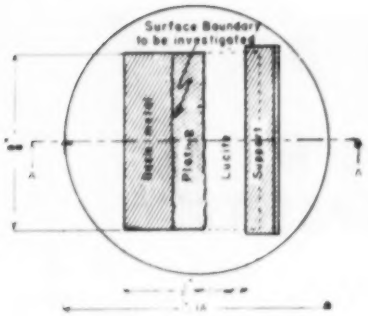


*Fig. 2. Diagram showing polished face of a taper-sectioned plated panel in a mounting block*

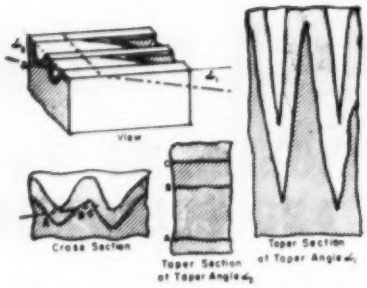


*Fig. 3. Illustration of the type of surface contour observed on cutting taper sections parallel and perpendicular to grooves on the surface of a plated specimen*

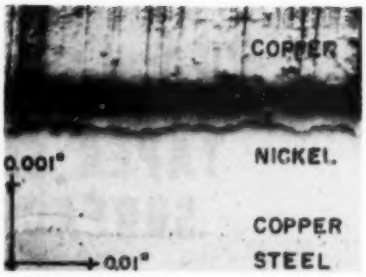


*Fig. 4. Taper section of a plated specimen continuing with an actual view of the upper surface. Unetched. Magnification 50X; in vertical direction by taper 10X*

ness should be removed from the specimen to expose the desired details of the surface. The boundary between the basis metal and the plating will advance toward the right-hand side of the specimen as shown in Fig. 2, and it is advisable to stop grinding when the surface boundary is close to the center of the polished face of the specimen. The thickness of the removed layer is not critical as it does not influence the magnification obtained by taper sectioning.

The directional magnification due to tapering is equal to the cosecant of the taper angle $\alpha$ and is given by the ratio AC/BC, where the angle at B of the triangle enclosed by the specimen, support, and base is a right angle (Fig. 1). Since for small angles, which are used in this method, both cosecant and cotangent have practically the same value, the substitution of AC by AB is permissible. Thus, to a close approximation, the magnification is the ratio of the distance (AB) between the lower edge of the specimen at A and the edge of the support at B, and the height of the support (BC).

For our purposes, a convenient tenfold magnification was obtained when using nickel-plated steel panels 0.05 inch thick supported by the same material at a distance of 0.5 inch. The enlargement of surface contours may readily be varied by predetermining the distance and height of the support. No other measurements are necessary, and a micrometer may be used to determine the latter.

### Interpretation of Taper Sections

The series of diagrams in Fig. 3 illustrate the effect of cutting sections of a plated surface containing parallel grooves. The section at taper angle $\alpha_1$ is typical of the effect observed when surface irregularities are magnified in the vertical direction and may be considered as a lengthwise distorted cross section. A section cut in a perpendicular direction, i.e., $\alpha_2$, may give rise to a polished face where a strip or area of the basis metal appears to be isolated to the electrodeposit and vice versa. It is obvious that this may lead to misinterpretation. For example, a sliver of basis metal adhering to the surface prior to plating would produce the same type of phenomenon. Thus it must be emphasized that only elongated irregularities in the cutting direction may be evaluated quantitatively. Furthermore, there will be no magnification or distortion of equiaxed inclusions, impurities, or crystals of the metallic structure in a taper section.

An illustration of how the surface contours of a basis metal are reflected in of nonmetallic inclusions, have been found subsequent electrodeposits is shown in Fig. 4. This is a photomicrograph of an unetched taper section cut from a copper-nickel plated steel panel on which an additional copper layer was deposited to protect the nickel surface for metallographic examination. This type of effect has been described by other authors. However, it is of interest to note that, on breaking away a portion of the Lucite mounting, an actual view of the top surface of the specimen may be seen under the microscope as a continuation of the taper section. The parallel lines observed on the surface of the upper copper layer are electroformed reproductions of the preparatory polishing irregularities in the original basis metal.

The use of etchants to develop structure poses another problem which is related to the small taper angle. A study of some copper-nickel plated steel panels showed that the narrow copper wedge adjacent to the steel may be rapidly attacked by an etching agent revealing the steel surface. This will be discussed in detail later.

Both the use of microscopic interferometry, to investigate the variation in surface smoothness of a specimen, and polarized light, to determine the presence

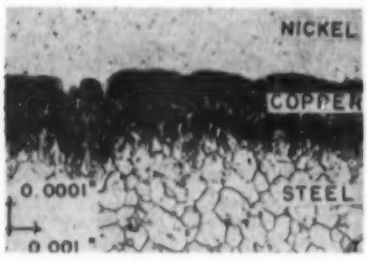


*Fig. 5. Taper section of a nickel-copper plated steel panel. Steel etched with 3 per cent nital, copper etched with cupric ammonium sulfate. Magnification 170X; in vertical direction due to taper 10X*

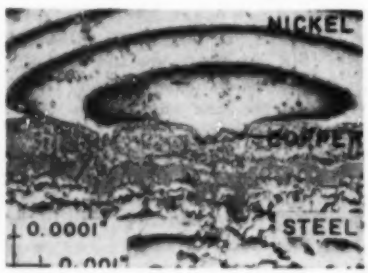


*Fig. 6. Same as Fig. 5, showing surface topography by interference pattern. Planar cylindrical reference plate set perpendicular to the surface contours*

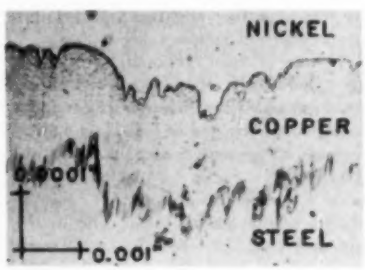


*Fig. 7. Taper section of copper-nickel plated steel panel etched for 2 minutes with 0.1 per cent sodium cyanide. Magnification 330X; in vertical direction by taper 10X*

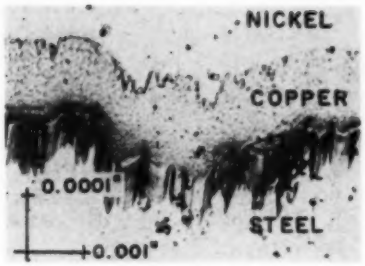


*Fig. 8. Same as Fig. 7. Etched for 4 minutes*

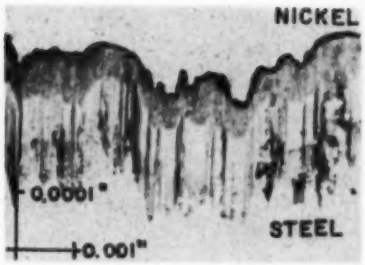


*Fig. 9. Same as Fig. 7. Etched for 10 minutes*

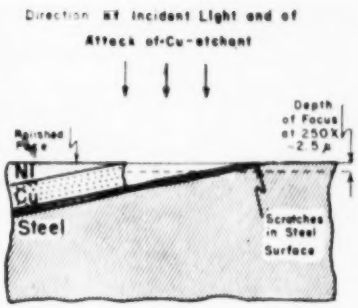


*Fig. 10. Diagram illustrating a cross section of a fully etched taper section*

invaluable in the interpretation of taper sections.

### The "Palisade" Layer

At the last American Electroplaters' Society Convention[7] attention was drawn to a peculiar appearance in structure observed at the steel-copper interface of a taper section of a copper-nickel plated automotive bumper guard. This is also illustrated in Fig. 5 and was referred to as a "palisade" layer. The origin and nature of this layer was unknown at that time but the question arose as to whether it was related to a type of surface bonding that would be a contributing factor in corrosion failure. Similar layers have been observed with all copper-nickel plated specimens when the copper was etched.

By the use of a simple interference method it is possible to study the surfaces of these specimens. In Fig. 6 a planar cylindrical reference plate was interposed between the microscope objective and the specimen. The black and white lines (interference fringes) produced indicate topographical levels. The distance between the sharp edges of two neighboring lines corresponds to a constant difference in height and is equivalent to half the wavelength of the light used for illumination. For the mercury green light at 5461 Å this is 0.27 micron. The closeness and number of the interference fringes at the steel-copper interface show that the palisade layer is a step to be considered as a groove approximately 2-3 microns deep.

In order to study the mechanism of the palisade layer formation a copper-nickel plated steel panel, cut at right angles to the direction of the polishing marks on the original steel surface and taper sectioned at the angle $\alpha$ (Fig. 3) was etched with a very dilute solution of sodium cyanide (0.1 per cent). Figures 7, 8, and 9 demonstrate the progressive attack of the copper by the etchant after periods of two, four, and ten minutes respectively. The initial development of the palisade layer reveals vertical parallel lines between the steel and copper undercoat which extend deeper into the copper layer with the time of etching. In a specimen in which most of the copper had been dissolved away it became obvious, by focusing these lines with a microscope, that they descended into the specimen and that the space previously occupied by the copper had the shape of a wedge with its sharp edge directed to the steel. A sketch of a fully etched taper section is illustrated in Fig. 10.

"Ghost" bands similar in appearance to the palisade layer and running parallel to the boundary of a silver deposit and a copper basis metal have been described by Moore.[8] He pointed out the difficulty of etching taper sections and observed, under suitable conditions, a distinct step between the copper and unetched silver. This was interpreted as a flowed layer caused by polishing. However, the palisade layer observed and illustrated by the authors has a well-defined appearance composed of lines which are diffuse only in the respect that they cannot be focused simultaneously throughout their entire length.

For interpreting taper sections it should be remembered that they have been cut at an oblique angle. On etching, the sharp edge of the copper near the steel basis will be dissolved first exposing the underlying steel surface. This part of the steel surface has not been metallographically polished and still possesses all the irregularities, polishing grooves, or scratches created by the pretreatment of the steel prior to electroplating. Since the specimen mentioned previously was mounted with the polishing scratches at right angles to the plating boundaries shown in the photomicrographs, the scratches must show up as vertical parallel lines. With progressive etching, more copper will be dissolved showing the continuation of these scratches until finally all copper in the field of vision will be removed. Since the surface of the steel which was originally in contact with the copper undercoat simultaneously forms an oblique angle to the observation plane, the contours of the scratches depart from the focused field and are diffused (ghostly). The explanation of the formation of the palisade layers by flowed layers caused by the polishing of the metallographic specimen in this case has been disproved.

It may be pointed out that by developing a palisade layer by etching a taper

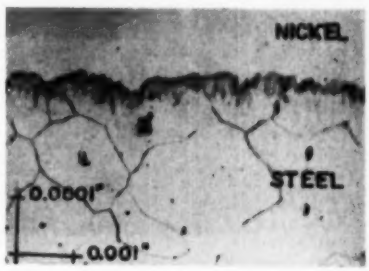


*Fig. 11. Taper section of a low-carbon (1010) steel with a commercial surface finish. Etchant 3 per cent nital. Magnification 330X*

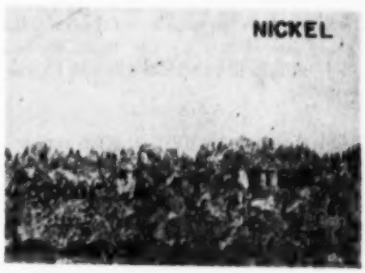


*Fig. 12. Taper section of a high-carbon (1085) steel with a commercial surface finish. Etchant 2 per cent nital. Magnification 330X*

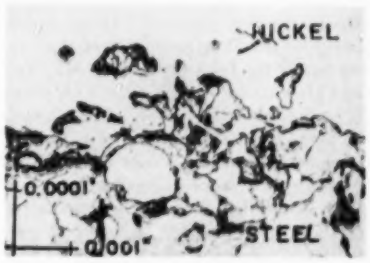


*Fig. 13. 1010 steel blasted with chilled steel abrasive G80. Etchant 3 per cent nital. Magnification 330X*

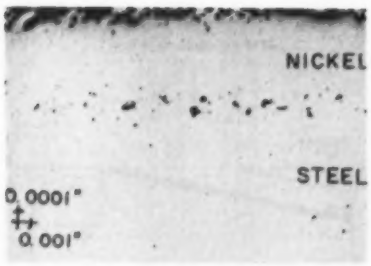


*Fig. 14. 1010 steel blasted with aluminum oxide (No. 150). Unetched, bright field illumination. Magnification 67X*

*Fig. 15. Same as Fig. 14, using polarized light. Magnification 330X*

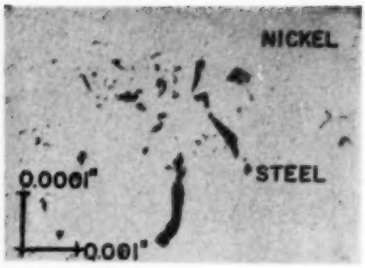


*Fig. 16. 1085 steel blasted with quarry sand (No. 200). Unetched, bright field illumination. Magnification 330X*

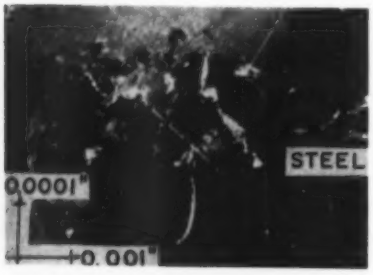


*Fig. 17. Same field as in Fig. 16, using polarized light*

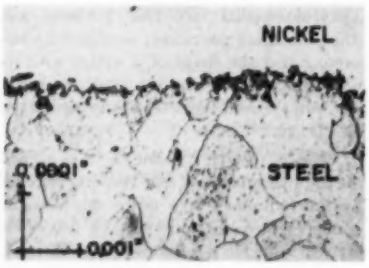


*Fig. 18. 1010 steel blasted with Arkansas silica (No. 325) in water. Etchant 3 per cent nital. Magnification 330X*

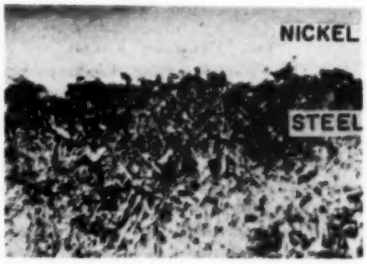


*Fig. 19. 1085 steel blasted with Arkansas silica (No. 325) in water. Etchant 2 per cent nital. Magnification 330X*

section, a perspective view of the original surface finish of the basis metal prior to electroplating is revealed. This view gives, in addition to the contours of the scratches which are shown by the taper section, their direction and their general characteristics.

### A Study of the Effect of Blasting on Steel Surfaces

During World War II it was found that steel panels blasted prior to silver plating showed consistently poor corrosion resistance and the opinion, held generally in the electroplating industry, is that blasting of the basis metal as a pretreatment is an operation not to be recommended for good quality plating.

The investigation by taper sectioning of some silver-plated steel panels, which had been blasted prior to plating, revealed a highly disturbed and darkened zone at the steel-silver interface. Under higher magnification it became evident that the surface of the basis metal was badly torn and observation under partially polarized light indicated the presence of nonmetallic inclusions. This led to a more general study of the surface effects produced by blasting with various abrasives; 1010 and 1085 steels were chosen as representative of those with low and high-carbon contents and all samples were subjected to a commercial polishing process (Lea C finish) prior to blasting to provide a reference surface. The abrasives used are listed below.

| *Abrasive* | *Medium* | *Mesh Size of Grit* |
|---|---|---|
| Chilled steel grit . . . | Air | 80 |
| Aluminum oxide . . . | Air | 150 |
| Quarry sand . . . . . | Air | 200 |
| Arkansas silica . . . . . | Water | 325 |

The blasting of the samples was carried out by an experienced operator and a visual uniform surface appearance taken as the criterion for finish. In general, the blasting time was of the order of 15 sec. The distance between the nozzle of the gun and the specimen was 12 inches and a pressure of 80 psi was used. All the photomicrographs relating to this investigation have an approximate tenfold magnification in the vertical direction due to tapering and the steel surfaces were plated before sectioning by depositing a nickel plating from a Watts nickel bath.

The appearance of the reference surfaces on the 1010 and 1085 steels under taper sectioning is shown in Figs. 11 and 12. It is observed that the commercial polishing employed produces a surface smoothness of less than 0.0001 inch.

The effect of blasting a 1010 steel with the chilled steel abrasive (No. 80) is shown in Fig. 13, and it is at once apparent that such a treatment results in a very rough surface. This photomicrograph also illustrates clearly a point of interpretation in taper sectioning that was mentioned previously. The areas of the basis metal isolated in the plating are probably not free fragments but are attached to the main body of the steel under the thin wedge of the nickel coating. This would be revealed by further grinding. The surface roughness observed with the 1085 steel was of a similar magnitude.

Figure 14 gives a general view under bright field illumination of an unetched specimen prepared from a 1010 steel blasted with aluminum oxide (No. 150). There is a relatively broad band of dark spots along the steel-nickel boundary and to determine whether they represent pores or inclusions the specimen was examined under polarized light (Fig. 15). The bright spots in this photomicrograph were found to be due to the presence of nonmetallic inclusions which are, in all probability, the aluminum oxide abrasive that has been kneaded into the steel surface during the blasting operation. A considerably greater number of inclusions was observed in this instance than when chilled steel was used as the abrasive.

Figure 16, under bright field illumination, and Fig. 17, using polarized light, illustrate the effect of quarry sand (No. 200) on a 1085 steel. Once again, the presence of included abrasive is observed together with a roughening of the surface.

Taper sections of the low and high-carbon steels subjected to liquid honing (No. 325 abrasive in water) are shown in Figs. 18 and 19 respectively. Comparison with the reference surfaces (Figs. 11 and 12) suggests that the liquid blasting treatment with a finer abrasive has little effect upon the surface roughness of the basis

metal although there may be a certain smoothing action. No appreciable amount of abrasive embedded in the steels was detected when the specimens were examined under polarized light.

The weight losses of the samples due to blasting were measured. Expressed in terms of the thickness of steel removed, it amounted in all cases to only a small fraction of the surface roughness produced. With relatively clean steel surfaces, as were used in this investigation, it would appear that the effect of blasting primarily results in a kneading of the surface and that the impact of an abrasive particle rarely eliminates a fragment of metal. It is not meant to imply that blasting does not produce a stock removal as the measured weight loss is found to increase with the time of operation. Rather, the action of the abrasive in cutting away the surface is a secondary effect. With a brittle surface, such as an oxide coating, the picture would undoubtedly be different.

In conclusion, it may be said that the behavior of low and high-carbon steels towards blasting is similar. Liquid honing produces the least distortion of the steel surface and leaves little or no embedded abrasive. Chilled steel (No. 80), aluminum oxide (No. 150), and quarry sand (No. 200) under air pressure detrimentally affect both the purity and smoothness of a basis metal surface.


### Acknowledgments

The authors are indebted to Dr. O. W. Ellis, Director of the Department of Engineering and Metallurgy of the Ontario Research Foundation and his staff members, Mr. S. J. Majka and Mr. R. Jamieson, whose advice and discussion helped greatly to clarify the problems involved in taper sectioning. The blasted samples were prepared at Eastman Kodak Company, Rochester, and Canadian Arsenals Limited. Dr. M. H. Jones of the Ontario Research Foundation assisted in the preparation of this paper.

Acknowledgment is also due to the Research Committee, Dr. E. J. Serfass, Lehigh University, Chairman; the Research Directing Subcommittee, Mr. L. C. Borchert, Houdaille-Hershey Corporation, and Mr. C. F. Nixon, General Motors Corporation, Chairman and Vice-Chairman, respectively; and the Project Committee, Mr. W. M. Tucker, Eastman Kodak Co., Chairman, who suggested and stimulated this investigation; Mr. W. G. Finlay, The M. & Y. Products Company; Mr. Charles Hubbleday, Canada Cycle and Motor Company, Ltd.; Mr. Leonard Wray, Pomac Electrotype Company, Ltd.; and Mr. Robert Hess, Houdaille-Hershey Corporation; for their contributions to Project No. 14.


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### DISCUSSION

Mr. Peter L. Veit (Grumman Aircraft, Long Island, N. Y.): Have you ever used these taper section techniques on anodized coatings in order to study the structure and porosity of such coatings?

Dr. Mohrnheim: No, we started this technique as a part of Research Project No. 14 which is concerned at the present time with nickel plating on steel. No other investigations have been made.


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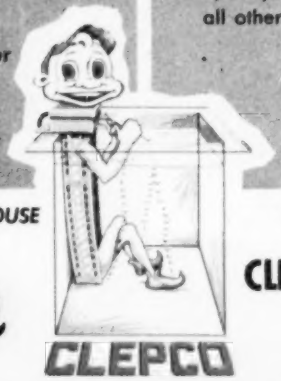


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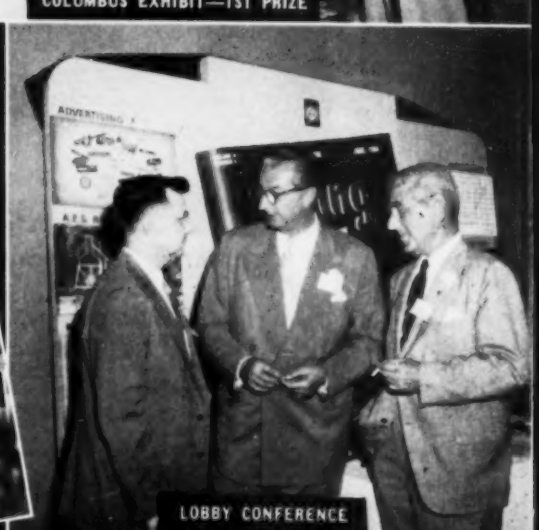

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## LADIES' PROGRAM

By Frances M. Hoffman*

We ladies again have the satisfied feeling that the New York Convention was the best in 1954. The men were trying to solve their nickel problems while the New York Ladies' Committee were solving the "golden" problems encountered by the fair ladies of the land.

Let's go back to Sunday night when the ladies enjoyed the film, "The Twenty-Four Dollar Purchase." This documentary of New York was superb, giving us an excellent picture of historical New York. Then followed the exchanging of friendly greetings, topped with refreshments, thus completing a perfect Sunday night for the Early Birds.

The get-acquainted and renew-acquaintance tea on Monday started the ladies' activities. The tea was sponsored by Lea Manufacturing Company, Wagner Brothers, Inc., and F. L. & J. C. Codman Company. The ladies enjoyed a lecture by Dr. A. E. Alexander, Assistant Treasurer of Tiffany and Company, Fifth Avenue jewelers.

The International Fellowship Club open house, sponsored by the Metal Finishing Suppliers Association, was filled with music, laughter, and tasty food, accompanied by "cool" drinks. The orchestra was delightful, and everyone had an evening of fun.

Oakite Products, Inc., sponsored the much anticipated Aunt Ella Party at the famous Tavern-on-the-Green in Central Park. David X. Clarin was our gracious host, and all ladies reported delicious food and a friendly, chatty event. Although Mr. Clarin made all the ladies happy, he made two ladies super-happy because they won the two pieces of silver from Peru. Our thanks, also, go to Mr. Carter, President of Oakite Products, for his gracious greetings to the ladies.

The theatre party Tuesday night was an evening of enjoyment, thanks to the Udylite Corporation, who furnished tickets to leading Broadway plays.

An outing on the Hudson River was made possible by Frederick Gumm Chemical Company, Inc. The cool, breezy atmosphere of the *Liberty Belle* was conducive to eating and dancing, as well as to just plain scenery gazing. This boat trip was enjoyed immensely by all.

Thursday was a full and profitable day for the ladies. The day started with a visit to the United Nations Building. This educational and exciting tour was made possible by Bart-Messing Corporation. Charming guides escorted the ladies through the interior of this famous and magnificent building. Finally, the ladies were privileged to purchase gifts from the Around-the-World Gift Shop.

On Thursday afternoon Joan T. Wiarda was again the gracious hostess for the Plato Party, sponsored by the MFSA. The ladies not only received Plato prizes, but each lady tucked away a beautiful pin from J. J. Siefen Company, a deck of playing cards from W. Green Electric Company, and orchids from Rapid Electric Company, as well as a generous and beautiful gift from the New York ladies.

The Annual Banquet on Thursday night was truly a lovely event. The floor show, the food, the orchestra, the prizes—together with all the gracious people—made this party a fitting climax to the New York Convention.

Thus ended the gay and colorful Convention in the world-famous City of New York.

All the ladies in attendance would like to convey to Mrs. Barbara Schore and the gracious Ladies' Committee of New York our deep appreciation for the kindness and generosity extended to us during the convention. Our special thanks go to Barbara Schore, who so ably planned and executed each event. All of us feel that the entire committee radiated much warmth and wanted to make us feel well received. They certainly succeeded. Thanks, New York Ladies.

And now—what about next year? The Ladies' Auxiliary of the Cleveland Branch extends to all of you a warm and cordial invitation to come to Cleveland. We have begun our plans and are looking forward to greeting each and every AES lady. The Cleveland Convention will be the best—in 1955.

*Mrs. A. R. Hoffman, Chairman of the Cleveland Ladies' Auxiliary, for the 1955 Convention in Cleveland.

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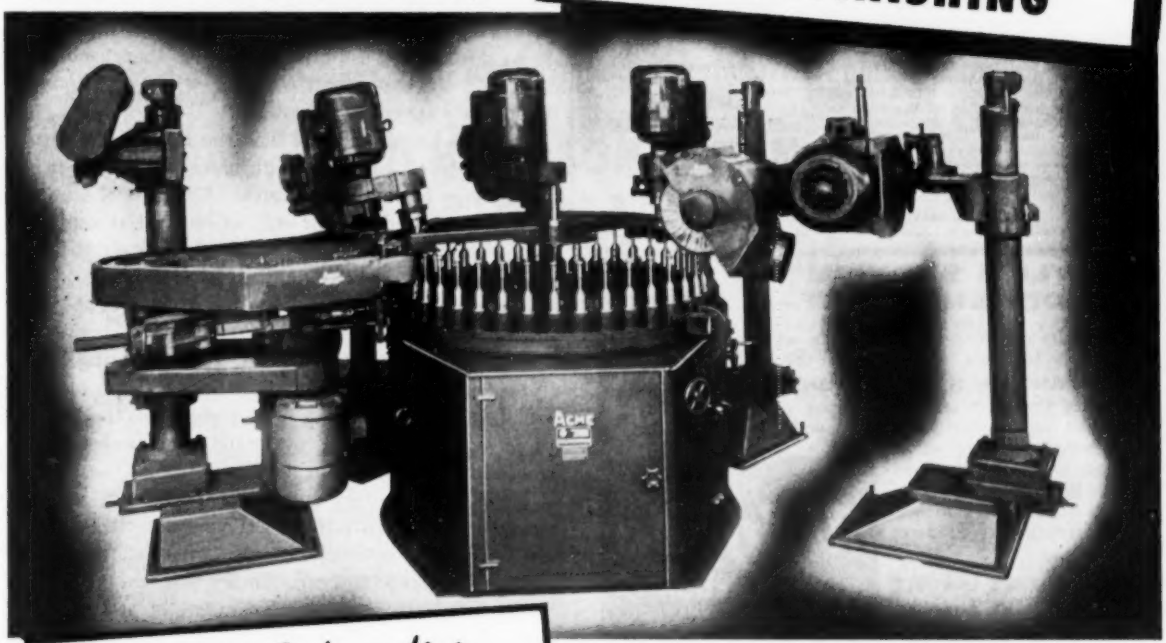


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# Book Review

DR. HAROLD J. READ

*Professor of Metallurgy, The Pennsylvania State University*

ASME HANDBOOK—METALS ENGINEERING DESIGN edited by Oscar J. Horger, 1953, xv + 405 pages. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price, $10.00.

Metallurgical progress has reached a point where all designers who use metals are not only presented with a bewildering variety of metals and alloys from which to make a choice, but also they must often select the most suitable heat treatment and metal-finishing produre to realize the optimum properties of the materials that they specify. The pertinent properties are exceedingly numerous, and the purpose of this volume is to discuss the essential properties that need to be evaluted by the design engineer when he chooses a metal for a specific application.

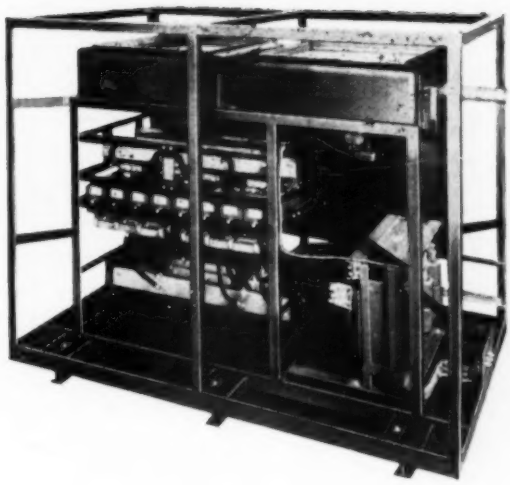
It must be emphasized that the book is *not* a mere compilation of tabular and graphical data interspersed with a few paragraphs of text. Material of this sort that is presented is used only as illustrative matter in connection with the well-organized discussions. As a matter of fact, the volume under discussion is only one of a projected four-volume series. Two of the other members of the series will provide collections of specific metallic properties as well as engineering tables.

The first of the six parts into which the book is divided is an exceedingly brief resume of the over-all problem of selection of materials, a subject which is treated in 27 chapters in Part Two.

Mechanical factors influencing corrosion are discussed in the third part of the volume. Stress corrosion, corrosion fatigue, fretting corrosion, and allied subjects are presented exceedingly well.

Part Four comprises seven chapters on testing (most nondestructive) and for some reason that completely eludes this reviewer is entitled "Metallurgical Factors in Design." Although the material is well written, it appears to have little place in this handbook. The presence of this material is particularly annoying when one considers that the space it occupies could have been used to present more of the material found in Part Five, namely, designing for production. It would seem that Part Five should have been a major part of the book instead of a mere 20 pages.

The concluding part contains chapters on design procedures that present the techniques and formulas used in actual design work. The authors of these significant chapters are well-known men in their fields (as are those for the entire book), and their contributions are authoritative.



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**The Influence of Annealing on the Structure and Hardness of Electrodeposited Chromium.*** C. P. Brittain and G. C. Smith, Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 10.

Electron-micrographs of chromium conventionally electrodeposited and then annealed at a series of temperatures up to 700° C are presented. The mean grain diameter obtained after a 1-hour anneal at 700° C was 7,900 Å; it diminished steadily with reduction of annealing temperature to 1460 Å for a 1-hour anneal at 450° C. The hardness showed a concomitant change, but this necessarily does not mean that increase of hardness is caused by decrease in grain size, changes during annealing of other factors such as oxide dispersion, stress, preferred orientation and hydrogen content may well cause the changes both in grain size and in hardness.

**The Prevention of Cracking in Nickel Electrodeposits.*** T. E. Such, Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 13.

The serviceability of nickel electrodeposits of adequate thickness mainly depends upon their physical properties. Methods of determining the internal stress and the ductility of these deposits are given. The use of these techniques in production control is illustrated by a typical case-history of a bright-nickel plating solution. The large variations in physical properties obtainable from any one type of solution are discussed and procedures for improving these properties are suggested.

**Studies of the Action of Organic Compounds at the Surface during the Electrodeposition of Nickel.*** Henry Leidheiser, Jr., Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 14.

Three types of experiments were performed that are important in understanding the action of organic compounds at the surface during the electrodeposition of nickel: X-ray diffraction analysis of nickel electrodeposits; cathode potential studies; and adsorption studies. Organic compounds differed in their ability to alter the grain size and the degree and type of preferred

*Paper presented at the 4th International Conference on Electrodeposition and Metal Finishing, London, England, April, 1954.


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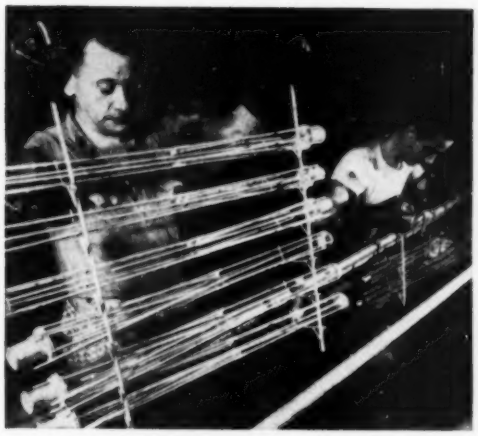

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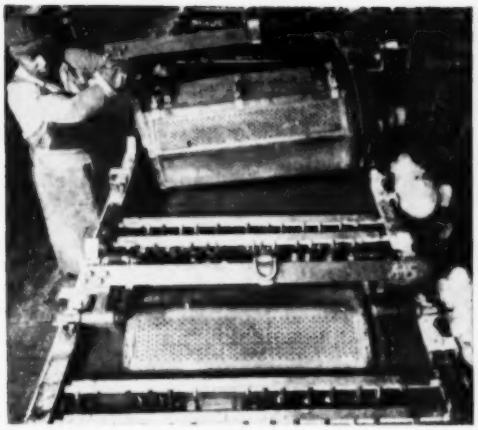

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## *Article Abstracts*

orientation. In general, ductile deposits were associated with a [100] preferred orientation and brittle deposits were associated with an orientation other than [100]. The ability of the organic compounds to increase the cathodic polarization was dependent upon (1) the acidic or basic character of the compound, (2) the size of the molecule, and (3) the number of available pairs of electrons in the molecule. Available pairs of electrons are defined as those that are capable of being shared with other atoms through association or chemical reaction without breaking completely the original bond between the atoms involved. Preliminary measurements were made of the adsorption of organic compounds from solution on single crystals of copper by analyzing the ellipticity imparted to plane-polarized light upon reflection from the surface. The adsorption measurements were correlated with the cathode potential results.

**Bright Nickel Plating—a Review of Progress.*** R. B. Saltonstall, Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 15.

The desirable properties of bright nickel baths and of the deposits formed from them, as listed 20 years ago by Eckleman, are reviewed. Progress towards their attainment is noted, and difficulties still to be overcome are pointed out.

**The Weathering of Nickel Chromium Electrodeposits.*** W. A. Wesley and B. B. Knapp, Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 18.

The atmospheric corrosion of nickel foils, both wrought and electrodeposited, proceeds by pitting leading to perforation. This result, coupled with earlier tests showing that "porosity-test" reagents can produce pores during porosity tests, suggests that properly produced nickel electrodeposits may be far less porous than has been thought.

A chromium film on top of nickel is helpful in the early stages of industrial atmosphere exposure but may accelerate pitting in the later stages owing to the galvanic action of the nickel/chromium couple.

The number per unit area, size, and shape of the pits vary widely. Factors influencing the type of pitting are the chemical composition and microstructure of the metal and its residual stresses.

**Automotive Organic Finishing.*** James T. O'Reilly, Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 19.

The history of automotive (motorcar) organic finishing is outlined briefly and general modern methods, especially those current in the U.S.A., are described. Some special applications and general future possibilities are indicated.

*Paper presented at the 4th International Conference on Electrodeposition and Metal Finishing, London, England, April, 1954

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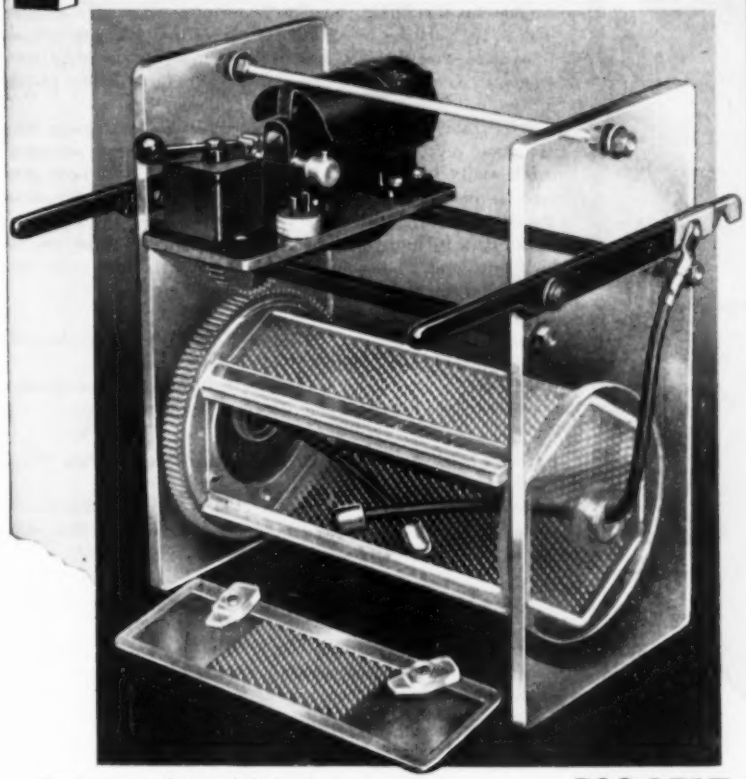

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## *Article Abstracts*

**A New Type of Primer for Resistance Welding.*** A. J. Elleman and N. D. P. Smith, Trans. Inst. Met. Finishing, 1954, 31, Advance Copy No. 21.

This paper describes an exploratory survey of alternatives to conventional electrically conducting welding primers, which suffer from the disadvantage that the very high proportion of conducting filler needed to give adequate conductivity for welding places severe limitations on the composition of the primer.

It is shown that nickel powder is a very much more effective conducting filler than nonmagnetic metal powders such as zinc. The nickel particles by virtue of their mutual magnetic attractions form chains of low electrical resistance, whereas for nonmagnetic powders, the interparticle attractions and the probability of interparticle contacts are much less.

It is possible to make coating compositions containing only moderate proportions of nickel powder that have adequate conductivity for welding. These compositions have been covered by patent. The nickel powder does not appear to affect the protective qualities of the coating adversely. The main disadvantages in the use of nickel as a conducting filler are its high price and the tendency, in common with most other metallic fillers, for the rate of settlement to be high.

**Disc vs. Belt Polishing.** G. Pahlitzsch & H. Windisch, Metalloberflache 8A17 (Feb. 1954), 8A67 (May 1954).

Advantages and disadvantages of belt polishing for specific applications are discussed and costs evaluated.

**Barrel Finishing.** L. Lechner, Metalloberflache 8A26 (Feb. 1954).

Abstracts of about 50 German patents on tumbling barrels and burnishing compounds (soap, cyanides, borates, tartrates, silicates, phosphates, surface active agents).

**Blasting and Tumbling.** W. Gesell, Metalloberflache 8A30 (Feb. 1954), 8A41 (March 1954).

Various types of blasting by air or liquid jet and the abrasives used (ferrous, nonferrous metals and nonmetallics such as sand, alumina, wood, nut shells, synthetic resins) are discussed briefly.

**Corrosion of Metals by Sulfur.** O. Kubaschewski and O. von Goldbeck, Metalloberflache 8A33 (March 1954).

The properties of metal sulfides, the mechanism of sulfide formation, the corroding action of gaseous or liquid sulfur, sulfur dioxide and hydrogen sulfide in the presence and absence of humidity—are discussed. The corrosive action of $SO_2$ on low carbon steel increases strongly above 50 per cent humidity, particularly above 80 per cent humidity.

**New Developments in Metal Spraying.** H. Reininger, Metalloberflache 6B6 (Jan. 1954), 6B39 (March 1954), 8A55 (April 1954), 6B73 (May 1954).

New equipment and methods for metal spraying, pre and aftertreatments and thickness measurement of sprayed coatings are given.

**New Interferometric Method for Surface Roughness Measurement.** E. Zehender, Metalloberflache 8A49 (April 1954).

The usual interference microscopic method fails at roughness values above 0.5 to 1 x $10^{-3}$ mm (20 to 40 microinch). A modified method using plastic replicas in suitable immersion media permits the measurement of roughness values between 0.5 to 20 x $10^{-3}$ mm.

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*Paper presented at the 4th International Conference on Electrodeposition and Metal Finishing, London, England, April, 1954.

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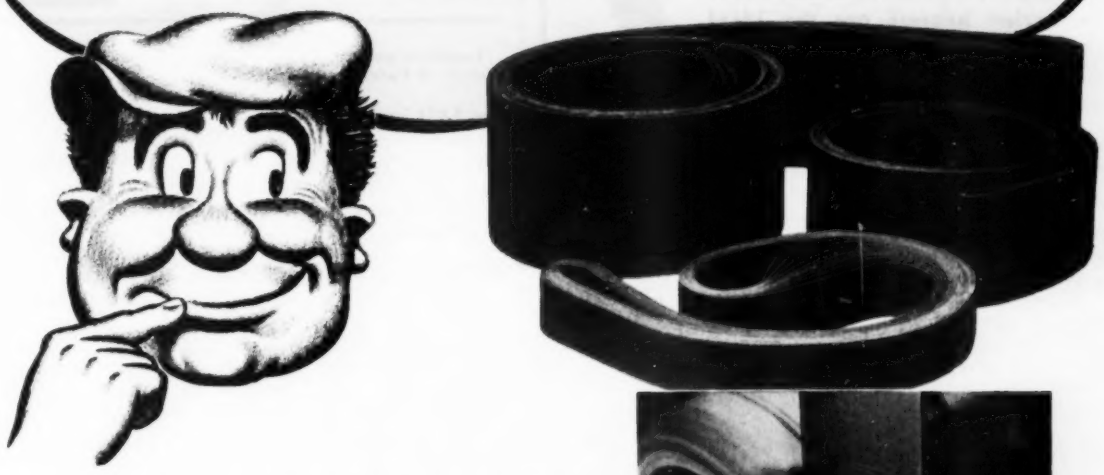

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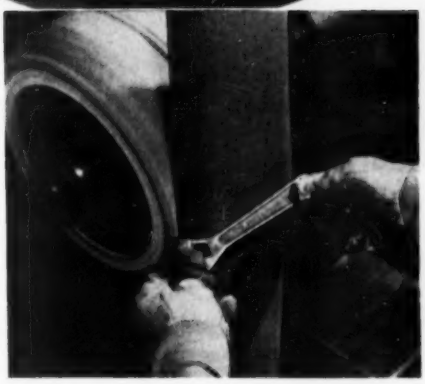

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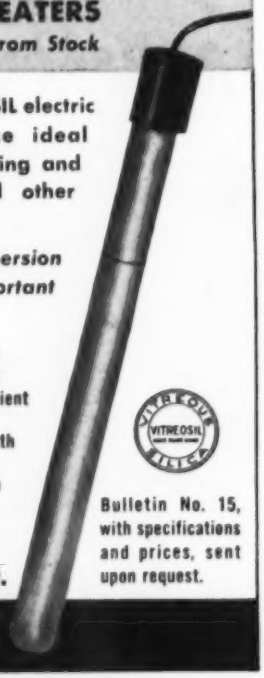

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# *Patent Abstracts*


DR. D. GARDNER FOULKE

Manager, Electrochemical Development
Hanson-Van Winkle-Munning Co.
Matawan, New Jersey

**Copies of patents may be obtained by writing to Commissioner of Patents, Washington, D. C. Price 25 cents each.**

**No. 2,674,551, April 6, 1954**—Ralph Dunlevy and H. Shoemaker, assignors to Kolene Corp., Detroit, Mich.

It describes the removal of carbon dioxide, formed by combustion of gas used for heating the alkali metal salt bath, from the treating area, thereby preventing the contamination of the molten salt on the roller with carbonates.

**No. 2,674,571—Method of Electropolishing Dental Appliances**—E. M. Posen, assignor to Nobilium Processing, Inc., April 6, 1954.

The method described is applicable to high cobalt or nickel alloys as for example: Cobalt, 60–65 per cent; chromium, 27–32 per cent; molybdenum, 2–6 per cent or nickel, 75–77 per cent; chromium, 18–25 per cent; beryllium, 3–5 per cent. The method consists of immersing the dental appliance as the anode in a bath of 5–22 per cent sulfuric acid, 0.25–5 per cent hydrochloric acid, 70–84 per cent ethylene glycol, and less than 8 per cent water. The bath temperature is given as 130° to 170° F (but current density limits are not given) for the alloys.

6 claims.

**No. 2,675,334—Metal Coating Process**—Daniel M. Gray and George L. Reymann, assignors to Stoner-Mudge, Inc., April 13, 1954.

This coating composition for the protection of tin plate (and other metals) from which containers are fabricated consists of an interpolymer vinylidine chloride (26–44.5 per cent) and vinyl chloride (61–64 per cent). The process consists of dissolving the resin in the proportion of 15–32 per cent by weight in a solvent consisting of not more than 15 per cent of ketone or ester solvents such as methyl ethyl ketone and the remainder being automatic hydrocarbons, coating the metal and baking at a temperature of at least 300°F.

6 claims.

**No. 2,675,347—Plating of Tin-Zinc Alloys**—Frederick A. Lowenheim, assignor to Metal and Thermit Corp., April 13, 1954.


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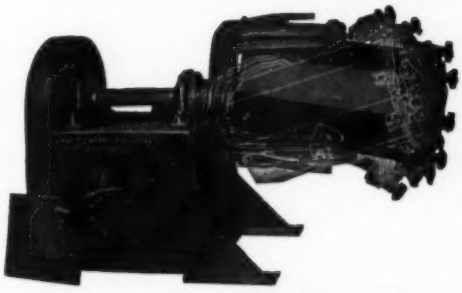

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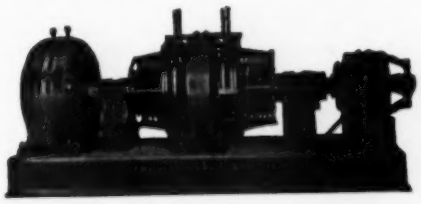

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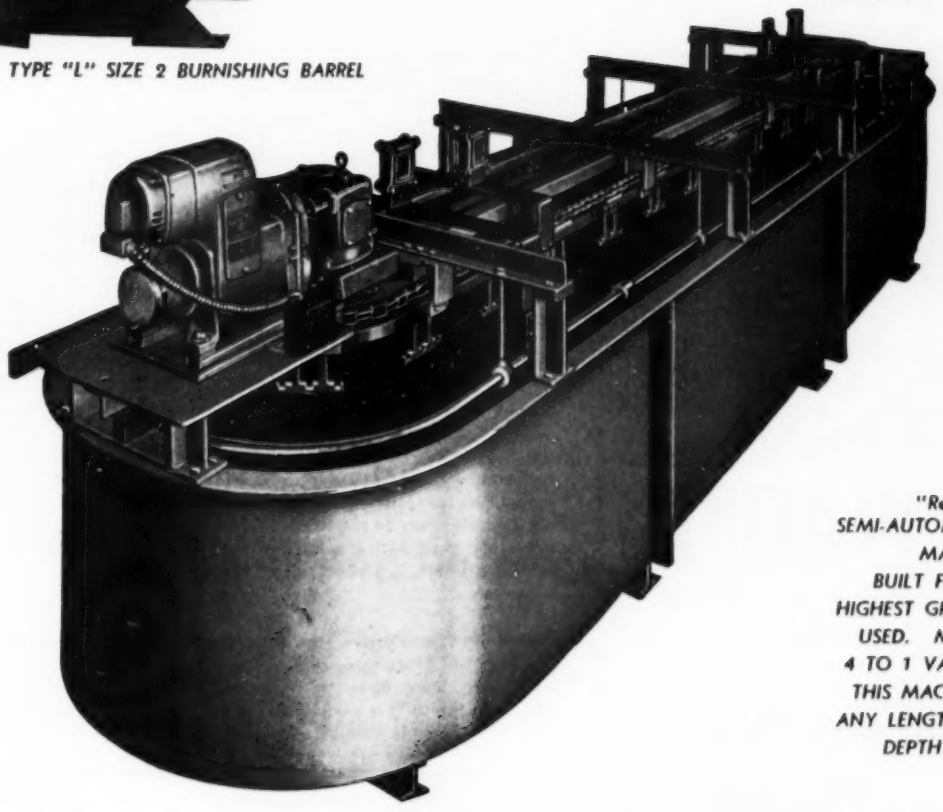

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## *Patent Abstracts*

An improvement over earlier tin-zinc electrodeposition processes, which consisted primarily of sodium salts, is claimed for baths formulated with potassium salts. Specifically, a process claimed for the deposition of tin-zinc alloy (15–25 per cent zinc and 85–75 per cent tin) in a bath containing 32–45 *g/l* of tin as potassium stannate, 3.5–9 *g/l* of zinc as zinc cyanide, 30–50 *g/l* of total potassium cyanide and 5–11 *g/l* of free potassium hydroxide. A current density of 30–40 asf at an operating temperature of 145° to 155°F is claimed.

1 claim, 3 figures.

**No. 2,675,348—Apparatus for Metal Plating**—Lawrence Greenspan, April 13, 1954.

This invention describes the equipment for the plating of record stampers, whereby a baffle of insulating material is placed in front of the record to provide good current distribution and means is provided in the assembly to supply air agitation to the face of the record as a part of the rack.

8 claims, 11 figures.

**No. 2,675,813—Apparatus for Conveying Pipe through an Electrolyte**—F. J. Kennedy, assignor to National Electric Products Corp., April 20, 1954.

This invention describes an improvement over the usual method of rolling pipe being plated through the electrolyte and over cathode contacts by conveying the pipe through the bath by means of an endless track above and on each side of the bath from which is suspended a series of longitudinally spaced pipe carrying arms. Automatic loading and unloading is provided.

11 claims, 7 figures.

**No. 2,676,900—Processes for the Removal of Oxides from the Surface of Metals**—H. R. Spence, A. N. Johnson, and S. G. Osborne, assignors to Hooker Electrochemical Corp., April 27, 1954.

An improved fused-caustic bath for the modification of refractory oxides (Fe Ni, Co, etc.) to render such oxides more acid soluble by virtue of the presence of oxidizing agents in the fused alkali bath—said oxidizing agents having the property of being regenerated *in situ* is described. Such oxidants may be nitrates, chromates, manganates, and permanganates of alkali earths or alkalis which may be regenerated by passing oxygen through the operating (fluid) bath in relatively small amounts in the presence of a carrier ($MnO_2$, $MnSO_4$, $V_2O_5$, $CrO_3$).

15 claims.

**No. 2,676,916—Plating on Aluminum**—Walter G. Zelley, assignor to Aluminum Company of America, April 27, 1954.

This invention describes a method for electroplating over aluminum which is a modification of the zincate dip procedure. The improvements claimed are: (1) the addition of at least one

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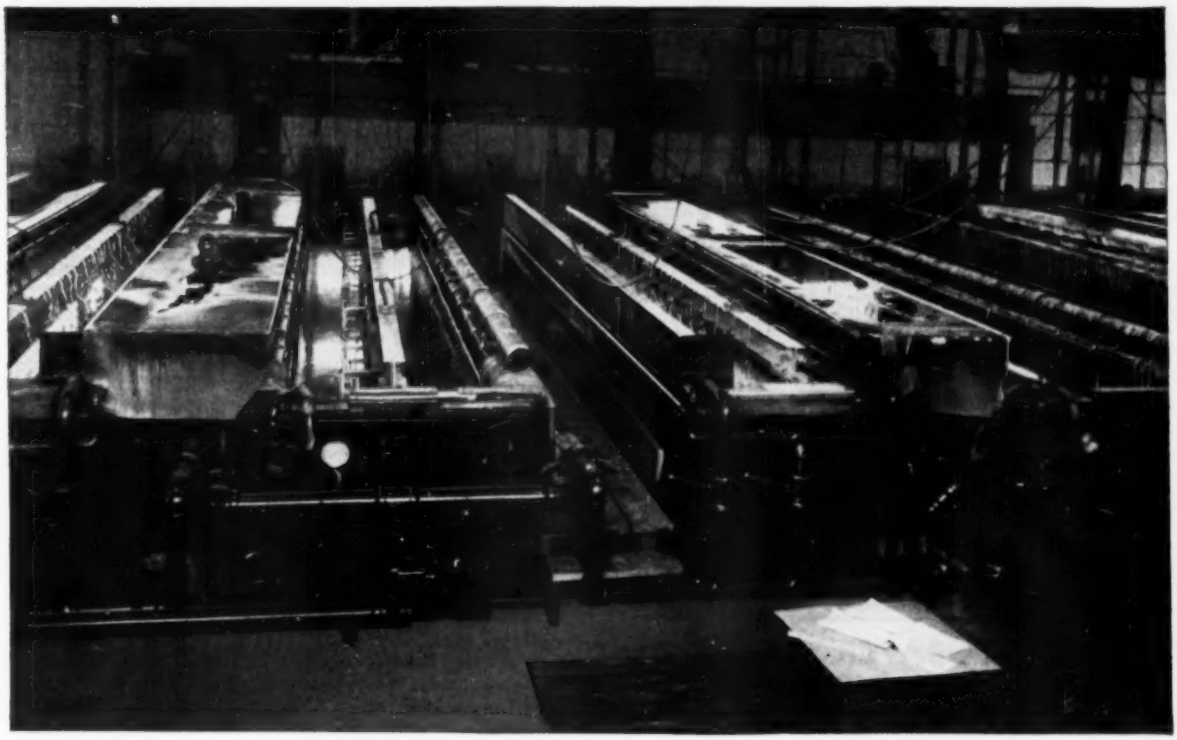

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TEAR OUT AND MAIL


# Patent Abstracts

of the hydrous oxides of the iron group (e.g., 0.5–7.5 g/l $FeCl_2 \cdot 6H_2O$) in the amount of 0.1–1.5 g/l in terms of metal; (2) the addition of at least 5 g/l of tartrate per gram of metal from iron group; and (3) a step wherein the preliminary zincate film is stripped (nmitric acid) prior to depositing a second film which is used as the base for electrodeposition. An example of the bath is given as follows:

| | |
|---|---|
| ZnO..... | 100 g/l |
| NaOH..... | 400 g/l |
| $FeCl_2 \cdot 6H_2O$... | 1 g/l |
| $C_4H_4O_6$..... | 5 g/l |

4 claims.

**No. 2,676,917—Method of Making Corrosion Resistant Articles Having a Bright Surface**—M. B. Hammond and Glade Bowman, assignors to Rockwell Spring and Axle Co., April 27, 1954.

This is an extension of the Schoonmaker and Stockton process (U. S. Patent 2,315,740) wherein a layer of nickel is deposited on steel followed by a layer of zinc after which the article is heat treated at about 700°F. The present invention claims a method for providing bright corrosion resistant surfaces by depositing at least 0.00005 inch nickel followed by a zinc deposit of 0.00005 inch, buffing to cause all the zinc to penetrate into and alloy with the nickel and form a bright surface, finally depositing a layer of chromium on the bright surface.

The discussion discloses that an article so treated and having a nickel deposit of 0.0004 inch, a zinc deposit of 0.0001 inch, and ten millionths of chromium withstood the standard salt spray test for 100 hours.

3 claims.

**No. 2,677,652—Method of Electrotinning Continuous Steel Strip**—Roy E. Howell, assignor to United States Steel Corp., May 4, 1954.

A method of plating steel strip from acid tin plating baths to eliminate what is known as "wood grain." The procedure is to lay down the early part of the deposit at a current density much below the operating range of the bath used for continuously plating steel strip, the current density being held below 20 asf, for at least the first pass from the negative contact roll to the first sink roll (vertical system).

2 claims, 1 figure.

**No. 2,677,653—Copper Electroplating Compositions and Process**—Allen E. Chester, assignor to Poor & Co., May 4, 1954.

This invention describes the use of a cyanide copper plating bath addition agent which is formed by the absorption of coke oven gases in an aqueous solution of an alkali followed by a treatment with cuprous or cupric oxide and sodium polysulfide.

The exact composition of the by-product cyanide material is unknown, but it is given in the discussion as:

| | |
|---|---|
| Sodium cyanide..... | 30 per cent |
| Sodium hydroxide..... | 2 per cent |
| Sulfides and organic..... | 0.015 per cent |
| Sulfur contaminents as $Na_2S$ | |
| Water..... | remainder |

22 claims.

**No. 2,677,654—Copper Electroplating and Compositions Therefore**—Allan E. Chester, assignor to Poor & Co., May 4, 1954.

An alkaline copper plating bath containing 0.4 to 1 oz/gal of dithiobiuret. The copper content of the bath may be 3 to 12 oz/gal, the free sodium cyanide 0.5 to 1.72 oz/gal and the sodium hydroxide 1 to 7 oz/gal. The temperature of the bath is given as 120° to 140°F and bright deposits are claimed at a current density of 20 amps/sq ft.

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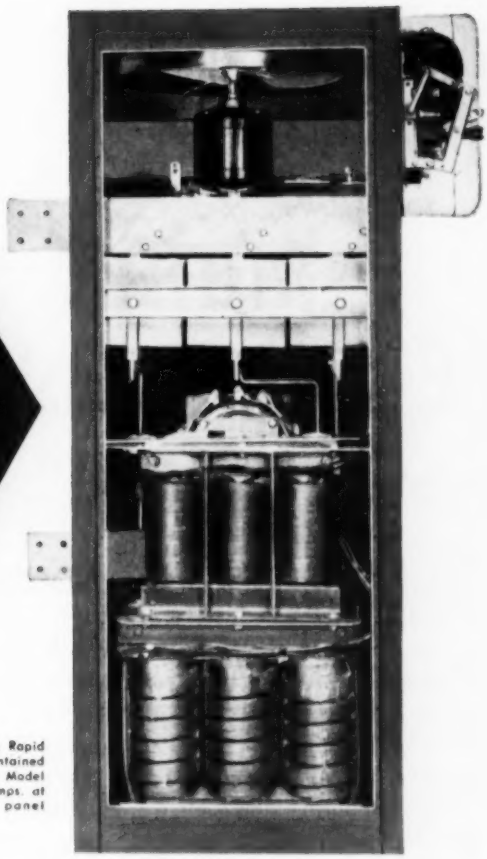

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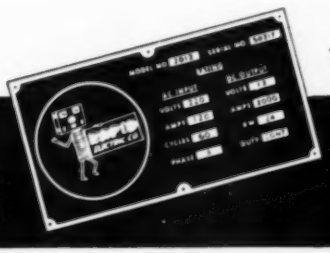

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## *Patent Abstracts*

**No. 2,678,291—Method and Materials for Producing Coated Aluminum**—F. P. Spruance, Jr., and N. J. Newhard, Jr., assignors to American Chemical Paint Co., May 11, 1954.

This invention covers a process for coating aluminum using an acid aqueous solution (or admixture for making said solution), the active ingredients being fluoride, dichromate, ions from the class of arsenate and phosphate, and ions from the class of chloride and sulfate with the ions being present in amounts stoichiometrically equivalent to:

| | |
|---|---|
| Fluorine | 0.15–12.5 g/l |
| Chromic acid | 7.4–66.6 g/l |
| Ions from class of $PO_4$ or $AsO_4$ calculated as $PO_4$ | 2–285 g/l |
| Ions of class of Cl or $SO_4$ calculated as NcCl | 1–50 g/l |

The broad claim covers a $F:CrO_3$ ratio of 0.015–0.135 and a *p*H of 1.0–3.3.

11 claims.

**No. 2,678,299—Method of Making Planographic Printing Plates**—C. F. Geese and D. B. Lytle, assignors to Printing Developments, Inc., May 11, 1954.

This invention relates to improvements in methods of preparing and conditioning the printing surfaces of planographic printing plates for lithographic and offset printing.

Claim 1 covers a method of depositing a water-receptive chromium surface layer for a bimetallic plate by immersing the smooth, ungrained plate in a 34 oz/gal chromic acid bath ($CrO_3$:$SO_4$ ratio = 100:1) and plating at 3/4–10 asi for 1–3 minutes interrupting the current for 15–60 seconds and again plating for 20–60 seconds to give dull, fine-grained chromium under specified temperature and current density conditions, e.g. 120°–133.5° F and current density of 8 asi.

The usual application of resist, hardening of the resist, and the etching operation is described as applicable either before or after chromium plating.

11 claims, 1 figure.

**No. 2,678,875—Chemical Brightening of Aluminum**—Roy C. Spooner, assignor to Aluminum Laboratories, Ltd., May 18, 1954.

A method for brightening aluminum, using a hot phosphoric-nitric acid bath for which it is claimed the addition of 1 to 150 g/l of silicic acid substantially reduces the attack of the bath on the aluminum without affecting the brightness obtainable. An example of such a brightening bath is given as follows: phosphoric acid, ortho (85 per cent), 80 parts; nitric acid (concentrated), 5 parts; acetic acid (glacial), 15 parts; silicic acid, 1 to 150 g/l.

5 claims.

**No. 2,678,876—Conditioning of Metal Surfaces**—G. Burnside, assignor to Radio Corporation of America, May 18, 1954.

This process concerns the production of a matte surface on brass or copper—as required, for example, prior to coating with a light-sensitive emulsion—by treating with an aqueous solution of ammonia persulfate (10 to 40 per cent) and hydrogen peroxide (0.3 to 1.5 per cent by volume). Claim 2 specifies the ammonium persulfate to be about 25 per cent and the hydrogen peroxide to be 0.3 per cent by volume. Claim 5 covers the use of the process for aluminum and magnesium as well.

6 claims.

**No. 2,678,908—Method of Forming Ferrotyping Surfaces**—William M. Tucker, assignor to Eastman Kodak Company, May 18, 1954.

A method is claimed for producing a maze of fine cracks in a metal ferrotyping surface by plating with chromium from a bath (chromic acid 390 to 410 g/l) wherein the $CrO_3$:$SO_4$ ratio is 104

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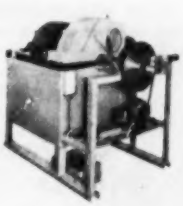

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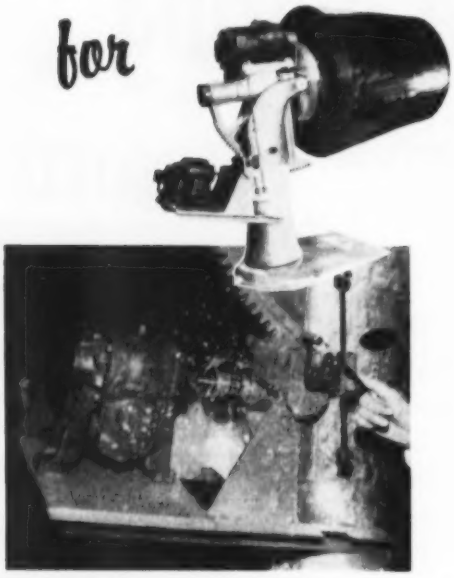

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## *Patent Abstracts*

to 110:1, the temperature is 115° to 122° F, the current density 175 to 225 asf, and the time ½ to 2 hours. This is followed, after rinsing, buffing, and a levigated alumina cleaning, by a second chromium plating operation in the same bath at an initial current density of 0.25 amp/sq in that is increased at intervals until a current density of 180 asf is reached. The second plating operation requires ½ to 1 hour.

1 claim.

**No. 2,678,909—Process of Electrodeposition of Metals by Periodic Reverse Current**—George W. Jernstedt and James D. Patrick, assignors to Westinghouse Electric Corporation, May 18, 1954.

Long cycle periodic reverse current plating is covered in this patent that specifically mentions copper, silver, zinc, cadmium, tin, gold, and brass. The cathodic cycle covered is 45 to 300 sec and a deplating current of at least 30 per cent of the plating current period, the average deplating current density being 30 to 90 per cent of the coulombs delivered during the plating portion of the cycle. References cited are four other patents issued to Jernstedt: Nos. 2,451,340 (Oct., 1948), 2,451,341 (Oct., 1948), 2,470,775 (May, 1949), and 2,558,090 (June, 1951).

8 claims.

**No. 2,678,910—Electroplating of Nickel**—Henry Brown, assignor to Udylite Corporation, May 18, 1954.

The basic claim in this patent is an acidic aqueous bath for the electrodeposition of nickel containing a nickel salt selected from the group consisting of the chloride, sulfate, fluoborate, or sulfamate of nickel and not more than 0.5 of at least one bath soluble fully esterified aliphatic polycarboxylic acid, the ester being unsaturated by virtue of double bonds. Claim 2 limits the polycarboxylic acid to 4 to 8 carbon atoms. The other claims specifically name a number of esters, e.g., di-(2 methoxyethyl) malcate, fumarate, or itaconate.

34 claims.

**No. 2,679,475—Metal Blackening Composition**—Joseph C. Singler, May 25, 1954.

A composition for blackening metals of the class consisting of brass, copper, nickel, steel, aluminum, zinc, stainless steel, and cadmium, consisting by weight of about: nickel chloride, 8 parts; ammonium chloride, 4 parts; rochelle salt, 1 part; zinc chloride, ¾ part; sodium chloride, 2 parts; ammonium molybdate, ¼ part. Claim 4 covers immersing the aforementioned metals in an aqueous solution of said composition and plating at a low voltage, the nickel chloride concentration being about 8 oz/gal. The disclosure mentions 6 to 9 volts for barrel plating and 4 to 6 volts for still plating. Zinc or cadmium articles can be dipped or electroplated.

4 claims.

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# AES News

### Dr. Serfass Reelected Chairman of Research Committee

Dr. Earl J. Serfass, head of the Lehigh University Chemistry Department, was reelected chairman of the Research Committee of the American Electroplaters' Society, it was announced in August by P. Peter Kovatis, Executive Secretary of the AES.

A recognized authority in the fields of chemistry, electroplating, and metal finishing, Serfass is responsible for nearly a dozen AES research projects being carried out in various universities and research foundations and in private industry in the United States and Canada. His main committee comprises 10 top men in the field. In addition, there are about 100 subcommittee men. More than 40 large, medium, and small corporations and several government agencies are represented by the Research Committee members. The yearly AES research budget is over $50,000.

Other members elected to the Research Committee at the recent New York convention include Leslie C. Borchert, Houdaille-Hershey, Detroit, Mich.; Robert J. Racine, Wyandotte Chemicals Corporation, Wyandotte, Mich.; Arthur P. Wrisberg, Davies Supply Company, St. Louis, Mo.; Myron B. Diggin, Hanson-Van Winkle-Munning Company, Matawan, N. J.; Lloyd O. Gilbert, Rock Island Arsenal, Rock Island, Ill.; Edwin R. Bowerman, Jr., Sylvania Electric, Bayside, Long Island, N. Y.; Arthur H. DuRose, Harshaw Chemical Company, Cleveland, Ohio; Dr. Edward A. Parker, Technic, Inc., Providence, R. I.; and Dr. William Blum, Washington, D. C.

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PROCEEDINGS:

Volume 9, 1921

Volume 11, 1923

PLATING desperately needs Volume 9, 1921, and Volume 11, 1923, to complete the indexing of AES *Proceedings*.

If you have a copy of either or both of these volumes, or if you know of anyone who has, please, please send them to PLATING or notify the Editor. PLATING will gladly refund the postage.

Isn't there a slick skillful sleuth who can slyly scent and spoor these stray serials?

### Style and Format Committee Recommends Changes

More than 50 suggested changes have been made by the Style and Format Committee for improving PLATING and other Society publications. The committee was established by Dr. George P. Swift, then President of AES, in 1953 to study all AES publications and to submit recommendations for their improvement. The committee—consisting of Dr. Walter Meyer, Dr. Ralph Muraca, Leslie Diveley, William Geissman, George Burnley, Mary Dickinson, and Chairman pro-tempore Peter Kovatis—met at National Headquarters in July. The Style and Format Committee was praised by the Executive Board for its splendid work and for the report that it submitted.

The recommendations made by the committee are being studied by members of the Executive Board, the Editorial Board, and the Research Committee. Some of the recommendations were put into effect in the August issue and others are being made effective with this issue.

Some of the main changes suggested by the Style and Format Committee are as follows: eliminating the annual *Proceedings* since the committee felt that *Proceedings* is a duplication of papers already published in PLATING; improving the cover of PLATING; moving the Contents Page of PLATING; improving Branch News; adding an Employment Column to PLATING; and changing the format of Research Reports to the page size of PLATING to obviate the resetting of material.

### Appointments to PLATING Editorial Board

Five appointments to the Editorial Board of PLATING were announced in August.

According to Managing Editor P. Peter Kovatis, the following appointments were for three years: Dr. Harold J. Wiesner, Bendix Aircraft Corporation, South Bend, Ind.; Robert D. Miller, Electric Auto-Lite, Sharonville, Ohio; and Howard J. McAleer, Formax, Detroit, Mich. John B. Winters of R. O. Hull, Cleveland, Ohio, was named to a one-year term as educational liaison member of the Cleveland Branch convention committee; and Dr. Abner Brenner, National Bureau of Standards, Washington, D. C., was named to a two-year term as liaison member of the Baltimore Washington Branch convention committee.

Other members of the Editorial Board are Edwin R. Bowerman, Jr., Sylvania, Bayside, Long Island, N. Y.; Daniel Gray, Oneida, Ltd., Oneida, N. Y.; William C. Geissman, Rockford Lock, Rockford, Ill.; Fred Fulforth, United Chrome, Philadelphia, Pa.; Charles W. Ostrander, Allied Research, Baltimore, Md.; Leslie C. Diveley, Cutler-Hammer, Milwaukee, Wis.; and P. Peter Kovatis, PLATING magazine, Newark, N. J.

### Branch Contributor to Research Fund

**Dayton Branch, AES. . .$208.62**

The Dayton Branch has contributed $208.62, in addition to its per capita tax. Dayton Branch is commended for its support of the AES Research program and for doing something extra for the Society.

### Industrial Finishing Exposition 1955

The 1955 Industrial Finishing Exposition will be held in conjunction with the 42d Annual Convention of the American Electroplaters' Society in Cleveland Public Auditorium, Cleveland, Ohio, June 20–23, 1955. The educational sessions and business meetings of the 42d AES Convention will be held under one roof in the same building as the Industrial Finishing Exposition. It is anticipated that over 200 exhibitions will use a total of 100,000 square feet in the arcade and upper level of the auditorium.

The 1955 Industrial Finishing Exposition will be attended by over 12,000 production supervisors, engineers, chemists, and other executives from over 8,000 electroplating and industrial finishing plants in the United States. Cleveland Public Auditorium is located in the geographical center of this industry and is overnight from 90 per cent of these plants.

Exhibitors will be those companies that manufacture equipment and supplies or furnish services used in industrial finishing and electroplating plants. Items to be exhibited will be the latest developments in services and products that enable the industrial finisher and electroplater to make his own manufactured product better with greater sales appeal and durability.

The American Electroplaters' Society has selected the American Decorating Company, Cleveland, Ohio, to manage the 1955 Industrial Finishing Exposition. Harold E. Bartlett and Albert W. Erickson, from the management staff of American Decorating Company, will serve as exposition managers.

The Cleveland Branch of the American Electroplaters' Society will be hosts for the 42nd Annual Convention and the 1955 Industrial Finishing Exposition. The convention committee is composed of E. L. Combs, Diamond Alkali Company, and C. F. Ott, Aircraft Plating and Polishing Company, general chairmen; F. H. Bruening, Oakite Products, Inc., chairman, banquet committee; John B. Winters, R. W. Renton and Company, chairman, educational program; J. D. Little, McGean Chemical Company, chairman, entertainment; J. T. Hyduke, Durable Plating and Supply Company, chairman,

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# *AES News*

finance; J. W. Baker, Cleveland Platers Supply Company, chairman, publicity; R. W. Renton, R. W. Renton and Company, chairman, athletic events; W. F. Acks, Bechtel-Laughlin Company, chairman, convention registration; W. M. King, Cleveland Graphite Bronze Company, chairman, plant visitation; and Mrs. A. B. Hoffman, Hoffman Plating Company, chairman, ladies' activities.

The exposition committee, under the chairmanship of Leon R. Westbrook, consultant, includes as committeemen: Howard H. Blouch, Chromium Corporation of America; Eugene L. Combs, Diamond Alkali Company; Herb Head, Chrysler Corporation; P. P. Kovatis, executive secretary of AES; and Dr. Ralph A. Schaefer, Clevite-Brush Development Company, division of Clevite Corp.

### Executive Board Travels Places

Probably the "traveling-est" Executive Board in AES history is that of 1953–1954. More than 80,000 miles were traveled by members of the Executive Board and the Executive Secretary. Of these, nearly 50,000 miles were traveled in attending Branch meetings. Members journeyed about 4,300 miles on Research matters, nearly 3,000 miles on Editorial problems, and over 25,000 miles in attending Executive Board meetings.

Board members made 66 visits to 25 different Branches in 1953–1954. They also attended 7 Executive Board sessions in 4 different cities, and attended 4 different committee meetings in 4 different cities on Research and Editorial matters.

Individual honors for traveling go to First Vice-President Clyde Kelly, who traveled over 17,000 miles on Society business. He visited 12 out-of-town Branches for a total of over 12,000 miles, and he traveled over 5,000 miles to attend Executive Board meetings.

## OBITUARIES

✣ **Edward J. St. Arnand,** charter member of the Toledo Branch, died July 24 at the age of seventy-nine years.

**St. Arnand**

Ed served as treasurer of the Toledo Branch from 1915 until his death and took a very active part in Branch and Society affairs. He attended Branch meetings until June, when he became ill.

"The Toledo Branch feels deeply the loss of a true friend and charter member," writes G. H. Bergeman, Branch Secretary. "We who knew him understand the sorrow that his wife and family are experiencing. May God's love be with them always and comfort them in their hour of sorrow."

✣ **Dr. Dwight Tarbell Ewing,** professor emeritus of chemistry at Michigan State College, an international authority on electroplating, and a member of the Jackson-Lansing Branch, died unexpectedly August 5 of a heart attack. He was sixty-six years of age.

Dr. Ewing received his B.S. degree at Parsons College, Fairfield, Iowa, and his M.S. and Ph.D. degrees at the University of Chicago.

He joined the Michigan State College faculty as an instructor in chemistry in 1914 and became professor of chemistry there in 1930. After teaching at Michigan State for 39 years, he retired in 1953, but he continued to serve as a consultant to the chemistry department.

**Ewing**

Dr. Ewing was active in the fields of chemical spectroscopy, surface chemistry, and the physical and chemical separation of vitamins. The author of about 75 published papers, he also held 7 patents on electroplating of chromium and other electrochemical processes.

Active in the American Electroplaters' Society, he was also a member of the Electrochemical Society; the Electro-Physical Society; the American Optical Society; the Physics Society; the American Association for the Advancement of Science; and the American Chemical Society, of which he was chairman four times.

Dr. Ewing did research on mustard gas for the National Research Council in World War I and worked on the Manhattan Project in World War II, receiving an award for meritorious research from Sigma Xi, national honorary scientific society.

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You can't blame us for being proud of the quality of the coating work produced by our customers. We have worked with them, and for them, to the very best of our ability, during the phenomenal growth of the coating industry. We know them well, and appreciate their loyalty and support. And we hope to have the privilege of serving them all for many years to come.

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# Branch News

### CAPITOL DISTRICT

The first annual outing of the Capitol District Branch was held at Geyser Park and Saratoga Lake on June 12, 1954.

Breakfast was held at the park, followed by a guided trip through the park and the spa. Mayor **Addison Mallory** sent his greetings and welcomed the group to Saratoga Springs. At the Nite-Cap Inn, overlooking Saratoga Lake, a clambake dinner later was served to 68 members and guests.

PAUL D. CALLAHAN, *Secretary*

### GRAND RAPIDS

**Carl Green**, President of the Grand Rapids Branch, announced the appointment recently of **Richard O. Watson** as Chairman of the local Research Finance Committee.

Watson is sales-service supervisor in the Western Michigan area for Wyandotte Chemicals Corporation. He solicits the cooperation of all local members in an effort to double Grand Rapids' Sustaining Members this coming year.

### LOUISVILLE

The regular meeting of the Louisville Branch was held April 15 at Korfhages Restaurant. President **P. H. Pate** opened the business and open meeting at 8:00 P.M. with 28 members and guests present. The roll call of officers was read, and Board of Managers **T. K. Allison** and **E. W. Eckerle** were reported absent. The minutes of the previous meeting were read and accepted.

**William B. Drake** gave a report on the Tri-State Regional Meeting. The 1955 Regional Meeting will be held in Columbus, Ohio.

The Technical Sessions Chairman, **Stanley J. Beyer**, reported that **Dr. H. L. Kellner** of the Lea Manufacturing Company, Waterbury, Conn., will be the next speaker on the subject, "Polishing of Metals." A General Electric movie, "Sight Seeing at Home," will be shown.

The following were elected to membership: **H. M. Switzer** and **Nathan C. McCone**.

Officers of the Louisville branch for the 1954–1955 fiscal year are as follows: President, **John W. Scholl**; First Vice-President, **William W. Francis**; Second Vice-President, **Kenneth C. Reifsteck**; Secretary and Treasurer, **Joseph G. Sterling**; Librarian, **Stanley J. Beyer**; Sergeant-at-Arms, **John Kehrer**; and Board of Managers, **Arthur A. Oertel, P. H. Pate**, and **Albert S. Engle**.

Delegates and alternate delegates elected for 1954 are as follows: delegates—**Arthur A. Oertel, Stanley J. Beyer**, and **Albert Steidle**; alternate delegates—**J. G. Sterling, Kenneth C. Reifsteck**, and **Wm. W. Francis**.


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**The Chromate Finish For Producing Inhibited and Lustrous Finishes on Copper, Brass or Bronze.**

- Produces a permanent lustrous finish even in recessed areas.
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## UNITS AND CONVERSION FACTORS*

Amperes per square decimeter x 9.3 = amperes per square foot
Amperes per square foot x 0.11 = amperes per square decimeter
Amperes per square foot x 0.007 = amperes per square inch
Avoirdupois ounces per gallon x 7.5 = grams per liter
Cubic foot . . . . . 1728 cubic inches; 28.3 liters; 6.3 gallons (British); 7.5 gallons (U.S.)
Cubic inch . . . . . 16.4 cubic centimeters
U.S. fluid ounces per gallon x 7.7 = cubic centimeters per liter
British fluid ounces per gallon x 6.25 = cubic centimeters per liter
Gallon (British Imperial) (Canadian) . . . . . 277 cubic inches; 4.5 liters
Gallon (U.S.) . . . . . 231 cubic inches; 3.8 liters
Grams per liter x 0.134 = avoirdupois ounces per gallon
Grams per liter x 0.122 = troy ounces per gallon
Inch . . . . . 2.5 centimeters
Liter . . . . . 0.22 gallons (British); 0.26 gallons (U.S.)
Ounce (avoirdupois) . . . . . 28.35 grams
Ounce (fluid) . . . . . 29.6 cubic centimeters
Ounce (troy) . . . . . 31.1 grams
Pound (avoirdupois) . . . . . 454 grams
Pound (troy) . . . . . 373 grams
Square centimeter . . . . . 0.155 square inch
Square decimeter . . . . . 15.5 square inches
Square foot . . . . . 144 square inches; 929 square centimeters
Square inch . . . . . 0.007 square foot

* Some of the values are given in round numbers to aid in speedier calculations.

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September, 1954 Do not use after November 15, 1954.

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## ELECTROCHEMICAL EQUIVALENTS*

| METAL | VALENCE | THICKNESS IN INCHES OF 1 OZ./SQ. FT. | GRAMS DEPOSITED PER AMPERE HOUR | AMP. HR./SQ. FT. TO DEPOSIT 0.001 INCH |
|---|---|---|---|---|
| Cadmium | 2 | 0.0014 | 2.1 | 9.73 |
| Chromium | 6 | 0.0017 | 0.32 | 51.8 |
| Cobalt | 2 | 0.0014 | 1.10 | 19.0 |
| Copper | 1 | 0.0014 | 2.37 | 8.99 |
| Copper | 2 | 0.0014 | 1.19 | 17.8 |
| Gold | 1 | 0.0007† | 7.36 | 6.2 |
| Gold | 3 | 0.0007† | 2.45 | 18.6 |
| Indium | 3 | 0.0018† | 1.43 | 12.0 |
| Iron | 2 | 0.0015 | 1.04 | 17.9 |
| Lead | 2 | 0.0011 | 3.87 | 6.9 |
| Nickel | 2 | 0.0014 | 1.10 | 19.0 |
| Palladium | 2 | 0.0012† | 1.99 | 13.5 |
| Platinum | 4 | 0.0006† | 1.82 | 27.8 |
| Rhodium | 3 | 0.0011† | 1.28 | 22.9 |
| Silver | 1 | 0.0013 | 4.03 | 6.2 |
| Tin | 2 | 0.0016 | 2.21 | 7.8 |
| Tin | 4 | 0.0016 | 1.11 | 15.6 |
| Zinc | 2 | 0.0017 | 1.18 | 14.3 |

* From calculations based on 100 per cent cathode efficiency.
† Troy ounce.

# FOOL-PROOF PROTECTION

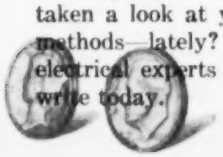
*Udylite equipment plates precision parts of this intricate vending machine mechanism*

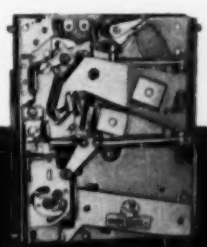
Every coin you drop in a vending machine is weighed, bounced, magnetized and sized . . . and if it is a slug or counterfeit it will be rejected.

Such ingenious machines as manufactured by National Rejectors Company, St. Louis, Mo., require extremely close tolerances and uniformity for the 400 plus parts.

In Udylite Automatic Plating machine, Barrel Platers and Junior Automatics—as used by National Rejectors, you see volume plating at its finest. Millions of parts are turned out in mass-plated quantities for machines that must be fool-proof.

Use of Udylite equipment and supplies are cutting costs, reducing man-hours, and boosting output for hundreds of companies in American industry today. Have you taken a look at your costs—and your competition's methods—lately? Udylite's research, engineering or electrical experts are quickly at your service. Call or write today.





Filed down pennies, washers, lead, zinc, copper, brass and German-silver slugs are all rejected by this sensitive mechanism.

THE Udylite CORPORATION
DETROIT 11, MICHIGAN

WORLD'S LARGEST PLATING SUPPLIER

## *Branch News*

President **P. H. Pate** turned the meeting over to Educational Chairman **Stanley J. Beyer.** After a brief talk, Beyer introduced **Ed Bruck,** President of Platers Supply Company, Indianapolis, as the speaker of the evening.

Bruck in his talk, "Relative Merits of Motor Generators and Rectifiers as a Source of Power for Electroplating," gave some very interesting information on the use of electrical power in small shops versus big plants, including the good and bad points of each.

Considerable discussion followed; and Bruck was given a rising vote of thanks for a very interesting talk.

J. G. STERLING, *Secretary-Treasurer*

### MELBOURNE, AUSTRALIA

The eighty-eighth regular meeting of Melbourne branch was held at the Melbourne Technical College, July 15. President **Parker** and 37 members and visitors were present.

**J. Dale** introduced the speaker for the evening, **Mr. Dempster** of the Defense Supply Laboratories, who spoke on "Phosphating"'

The lecturer pointed out the difference between the coatings usually applied by the electroplater and the phosphate coating that is a conversion coating. The use of the phosphate coating on steel under paint to increase corrosion resistance and paint adhesion is well known and widely used, but there are other applications of importance. The friction reducing properties are being employed on machine parts, and the drawing of steel is facilitated by the coating. The electrical insulating property of the coating is also being used.

After touching on the history and the chemistry of the process, Dempster outlined the equipment being used and various methods of application. The coating can be applied by an immersion or spray process. Cleanliness of the material prior to the phosphating treatment is essential. The crystal size of the phosphate coating was greatly influenced by the metal pretreatment. The best corrosion resistance performance has been obtained over steel by flash zinc plating and phosphating. The phosphating process suitably modified could be applied to other materials such as galvanized structures and zinc-aluminum alloys.

Slides were shown, providing a clear picture of the results obtained with phosphate coatings, and some equipment used in the phosphating process was on display.

A comprehensive chart setting out the types and applications of the various phosphate coatings was distributed among those present.

The June meeting was held at the Melbourne Technical College with President **Parker** and 45 members and visitors present.

Subject of the technical session was "Uses of Plastics in the Chemical Industry." The speaker, **L. E. Errey,** Assistant Research Manager of Monsanto Chemicals, Ltd., was introduced by **J. Dale.**

Errey pointed out the rapid increase in the number of plastics being made available for industry. Although these materials show some remarkable properties, they must be regarded as engineering materials and treated on their merits.

Errey then outlined the chemical composition and manufacture of the more common or promising materials, such as polyethylene, styrene, PVC, and Teflon and then the thermosetting type materials—polyesterresins and furanes.

JOHN J. DALE, *Secretary*

### MILWAUKEE

President **Fred Anderson** called the monthly meeting to order on May 27 with 60 members and guests present. The annual session was discussed, and all agreed that it was a success both educationally and financially since 96 were present for the educational session and 446 at the evening social function. The


. . . the result of 10 years of development

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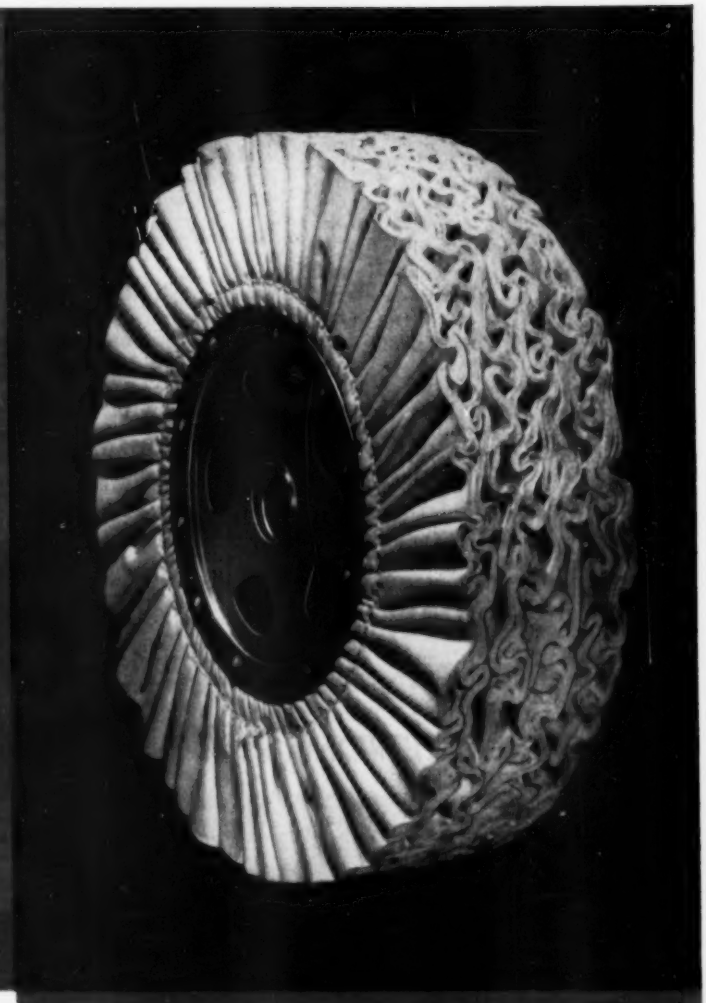

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**The Bullard Clark Company**
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## Branch News

membership is growing and the Secretary announced that 51 new members were accepted this year. Three applicants were accepted and welcomed at this meeting.

The following officers were elected unanimously: President, **Glen Schwemer**; First Vice-President, **John Schneider**; Second Vice-President, **Herman Tessman**; Secretary-Treasurer, **Clifford Peter**; Librarian, **Arthur Linn**; and Board of Managers, **Phil Ritzenthaler.**

The speaker of the evening, **Ray Stricklen** of Allied Research Products, spoke on existing chromate finishes for aluminum and magnesium, as well as those for silver and the copper alloys.

At the meeting on June 4, the first order of business was the installation of officers. **Henry Bornitzke** installed the officers and charged them with their duties. Past President **Fred Anderson** was presented with a Past President's pin in token of his services for the past year.

A review of the ASTM Committee B3 report on changing the salt spray specifications from 20 per cent to 5 per cent salt solution was read. Members were cautioned about salt spray testing as to the temperature of the test and also on definition of a failure.

CLIFFORD A. PETER,
*Secretary-Treasurer*

### NEWARK

The regular meeting of the Newark Branch of the American Electroplaters' Society was held June 18 at the Robert Treat Hotel.

The meeting was called to order by President **John Gumm** and the roll call found all officers present. Communications were read from Headquarters and the New York, Milwaukee, and Philadelphia branches.

Applications for membership were received from **Robert Linzer, Alfred Cafara,** and **Adolph G. Buschow. Albert H. Capo** and **J. Richard Relick** were elected to membership, and **William T. Walling** was transferred to Chicago and **Edward F. Foley, Jr.,** to New Haven.

**John Banta** moved that **George Wagner,** in view of his long and devoted service to Newark Branch, be made an Honorary Member of the Branch. This was seconded and passed unanimously.

**L. Donroe** suggested that the Board of Managers consider others who have contributed to the Branch over the years in terms of honorary membership. Gumm said this would be done in the future.

Librarian **Clifford Struyk** introduced **Dr. Dodd S. Carr,** Bart Manufacturing Company, who discussed electroforming from the standpoint of applications, advantages, types of molds, parting treatments, and selection of the bath to obtain the desired physical properties. He pointed out that increasing the chloride content improves the strength and hardness and that the sulfamate bath is useful because of low stress, a property that can be controlled further by purification and the use of addition agents.

**Dr. C. E. Kircher** of Detrex Corporation described the use of sonic energy for cleaning. Kircher explained the principles behind this new tool, as well as the applications and limitations at present. Following an extended question period, a demonstration of sonic cleaning was presented to the 60 members and friends present.

D. GARDNER FOULKE,
*Recording Secretary*

### PHILADELPHIA

"The results of the AES Research program are unexcelled by any other technical society." **E. H. Bowerman** of Sylvania Electric told Philadelphia Branch members at "Sustaining Members' Night" at the Engineers' Club recently.

Bowerman, a member of both the AES Research Committee and the PLATING Editorial Board, described the various research projects and their importance. He urged members to submit ideas to the Research Committee because "future problems and where to work on them are important items always being considered."

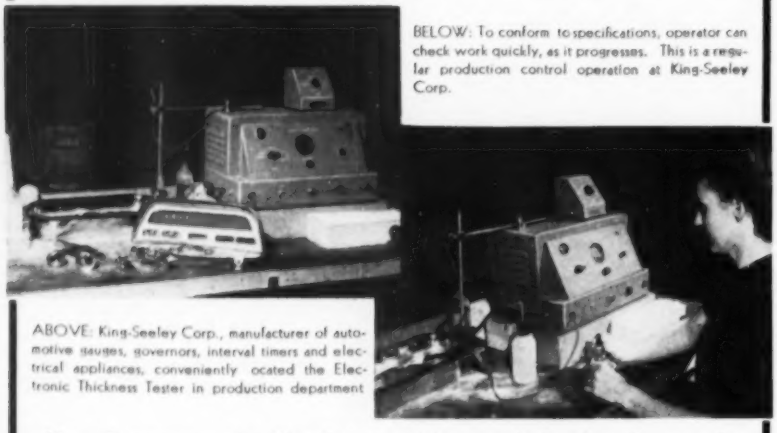
More than 50 members and guests attended the meeting which honored AES Sustaining Members in the Philadelphia area.

A talk by **H. L. Hovis** of the Hamilton Watch Company on "Plating on Small Parts for Instrument Manufacture" followed Bowerman's address.

The May meeting of the Branch featured a guided tour of the General Motors Ternstedt Division Plant at West Trenton, N. J., on May 21. Close to 130 members took part in the junket.


KING-SEELEY CORPORATION, ANN ARBOR, MICHIGAN

solves thickness testing problem
WITH
KOCOUR ELECTRONIC THICKNESS TESTER



BELOW: To conform to specifications, operator can check work quickly, as it progresses. This is a regular production control operation at King-Seeley Corp.

ABOVE: King-Seeley Corp., manufacturer of automotive gauges, governors, interval timers and electrical appliances, conveniently located the Electronic Thickness Tester in production department

About 2 years ago the King-Seeley Corp. purchased the Kocour Electronic Thickness Tester . . . evaluated the instrument and have been using it since with confidence and satisfaction. Mr. C. F. Waite of that company wrote a paper, "Thickness of Electrodeposited Coatings by the Anodic Solution Method" concerning their problems and how they were solved.

King-Seeley Corp. is one of the many companies which are now saving hours of control and production time with the Electronic Thickness Tester. In addition, more efficient operation and higher standards of quality can be maintained confidently.

Why not investigate the possibilities today. See how the Kocour Electronic Thickness Tester can solve your problems.

Write for literature and get your copy of "Thickness of Electrodeposited Coatings by the Anodic Solution Method."

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*Always specify KOCOUR TEST SETS from your supplier!*

Announcing

# SILVER PLATING PROCESS 3K

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**W**hy do we say 'Tailored for Industrial Use'? Because from our observation of and research into the plating of silver and other precious metals for both decorative and industrial use, we recognize the fact that the plating requirements of each differ widely. That's why we have developed two Bright Silver Plating Processes.

**The Lea-Ronal Process 3K, for industrial application, has the following outstanding features:**

- simplicity and ease of operation;
- crystal clear solution, enabling you to observe the work throughout the plating cycle.
- the Brighteners are completely stable, permitting continuous or intermittent operation with same excellent results. Frequent carbon treatment is not necessary to remove harmful breakdown products.
- the process provides high speed plating characteristics (Hull Cell 0-100 amperes per square foot with agitation 18 feet per minute) and at ROOM TEMPERATURE. This high speed feature will enable you to produce more work from existing equipment.
- deposits are bright.
- deposits are soft and ductile and can be heavy; in some cases, deposits as thick as 0.060" are being produced.
- deposits have higher tarnish resistance than those from conventional silver plating processes.
- can also be used for barrel plating.
- adaptable for many decorative as well as industrial applications.
- further, your existing silver solutions can easily be converted.

Bear in mind that we're not asking you to be the guinea pig. Lea-Ronal Bright Silver Process 3K has been fully production-tested in both still tank and barrel operations. Further, you won't have to start fresh, so to speak. You can start with your existing silver solutions.

**Why not place a trial order today and learn for yourself as quickly as possible that here is a way you can produce better work at lower cost?**

## Lea-Ronal Inc.

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**42-48 27th Street, Long Island City 1, N. Y.**



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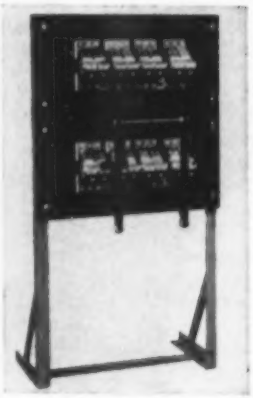
# REVERSING SWITCH



## Now Available in 3000 Ampere Size

For heavy duty service, the Columbia Double Pole, Double Throw, Reversing Switch with 3000 amperes capacity has been developed for use on direct current up to 15 volts. It consists of two 16" x 32" ebony asbestos panels mounted on angle iron supports 60" high. A manually operated handle, with effective leverage, permits the operator to easily open or close the switch mechanism. By placing the handle in a neutral position the line current is disconnected.

A total of sixteen heavy duty toggle-switches are mounted on the panels four for each current direction. The cam action of the switch mechanism assures positive contact pressure. Contact surfaces are automatically cleaned by the inherent wiping action of the laminated copper moving contacts. Switch is rear connected, and is furnished complete with reversing jumpers and four terminals for outgoing and incoming bus bars. Stationary and movable contacts are readily replaceable.

While designed primarily to reverse the current flowing through a plating tank, the switch can also be supplied, when specified, for use as a series-parallel switch for double commutator generators.

Columbia Reversing Switches are also available in sizes of 300, 500, 1000 and 2000 amperes.

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# *Branch News*

Sellersville, Pa., was the site of the next meeting of the branch on June 19. A large turnout enjoyed a full day's outing at The Old Mill with good food and beverages and fun arranged by a hard-working committee.

I. W. Marcovitch, *Secretary*

### SAN FRANCISCO

Five members were named to represent the San Francisco Branch at the New York Convention at the June 10 meeting held in the Hotel Leamington, Oakland. They included **C. Festa**, delegate; **E. D. Kettman**, delegate; **J. Hite**, delegate; **B. Trygstad**, alternate, and **H. Smith**, alternate.

In the absence of a scheduled speaker, who was unable to attend, an open discussion was held on vapor degreasing, emulsion cleaners, proprietary cleaners, and silver and nickel plating on stainless steel.

It was announced that there would be no regular meetings for July and August, with the first full meeting scheduled in September.

F. W. Browning, *Secretary-Treasurer*

### SOUTHEASTERN

The regular meeting was held June 11 at the Belmont Steak House. After dinner the meeting was called to order with 12 members present and **Ray Charles Steffey** presiding. Ladies' Night was discussed and August 14 was set for a dinner-dance at the Druid Hills Golf Club.

The speaker of the evening was **Paul Sheppard**, Roto Finishing Corporation, Kalamazoo, Mich., who gave a talk on barrel finishing and deburring. Discussion and questions followed his talk.

W. T. Weymouth, *Secretary-Treasurer*

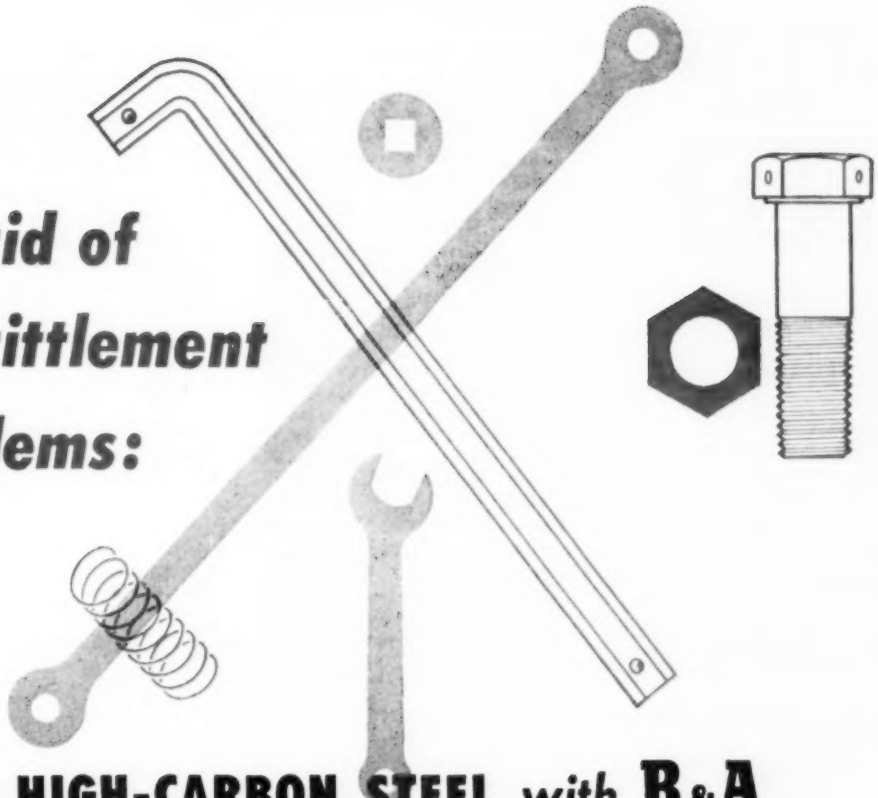
### SYDNEY, AUSTRALIA

President **Millward** called the meeting to order and after the general business session he welcomed **Warwick K. Mundy** into the branch.

Three new active members were voted in and three other applications were handed to the Secretary. We feel that these applications for membership are an early result of a concerted membership drive we have been staging. Many application forms are still out, and we expect a large number of these to be returned with the appropriate joining fee.

Our June regular meeting took the form of a Plating Forum presided over by **B. W. Armstrong**. All manner of topics were discussed and most problems and queries were answered satisfactorily. The fact that the meeting was adjourned at 10:40 P.M. indicated the interest shown in this form of meeting. One of the many questions submitted was "whether vacuum metalizing could become a serious

# Get rid of embrittlement problems:



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# *Branch News*

competitor to the electroplating industry." This provoked a very interesting and lengthy discussion and so many members expressed a desire to know more about vacuum metalizing that the management committee is now endeavoring to obtain a suitable lecturer on the subject.

Instead of a monthly general meeting in July, Sydney Branch held its first annual ball to celebrate the tenth anniversary of its first meeting, which was held on November 17, 1943.

The ball was held at the Roseland Golf Club, which provided a perfect setting for the event. Tastefully decorated tables and a superb supper helped to make the evening a success.

President and Mrs. **Millward,** aided by First Vice-President and Mrs. **Murphy,** received the guests. Every lady was presented with a plastic fruit bowl and both ladies and gentlemen were also given souvenir programs and lucky numbers that were ultimately drawn by Mrs. **Coulson** and won by Mrs. **Corkey** and Mr. **Mawson.** Prizes for novelty dances were distributed by First Vice-President Murphy. The evening was a success socially, as well as financially.

M. A. TAYLOR, *Secretary-Treasurer*

## SYRACUSE

The Syracuse Branch held its May meeting at Bill Richards' Restaurant, Syracuse, N. Y., on May 17. Thirty-four members were at the premeeting dinner and 36 members attended the meeting following the dinner.

The speaker of the evening was **Frank Eddy** from the Waterbury Branch, who spoke on "Organizing the Finishing Department."

Refreshments were provided by H-V W-M with **Charles Bridgett,** their representative, acting as host.

The Syracuse Branch annual clambake was held on Saturday, June 5, at Storto's, Jamesville Lake. One hundred and four members and guests finished the season in a very satisfying manner.

A. G. MARTINEAU, JR.,
*Recording Secretary*

## WICHITA

An installation of officers, a tour of the Boeing Aircraft plant, a board meeting and a final dinner-meeting took place in Wichita in the months of April and May.

New branch officers installed on April 28 included **R. A. Balbierz,** President; **J. H. Lewis,** Vice-President; **W. Turner,** Secretary; **O. French,** Treasurer; **F. Swift,** Librarian; Board of Managers—one year: **A. Augustine** and **C. Curry;** two years: **J. E. Pirrone** and **B.Dawson;** three years: **C. Ziesenis** and **H. E. Babst.** Other officers installed were **R. Beatie,** Publicity Chairman; **F. Micheals,** Membership Chairman, and **C. Wilson,** Question Box Chairman. A tour of the Boeing Aircraft plant followed the installation.

A board meeting was held at the home of J. Pirrone on May 12, and the final meeting before the summer vacation period was held on May 26 at the Catering Kitchen. **Godfrey Moore,** chief chemist of Emmar, Inc., featured with his talk on "Chemistry of Paints." The usual question-and-answer session followed the talk.

The Wichita Branch extends an invitation to all AES members to visit at any of its Branch functions. Regular meeting night is the fourth Wednesday of each month, starting September. Write to W. Turner, c/o Pirrone Plating, Wichita, for further information.

R. H. BEATIE, *Publicity Chairman*

## BRANCH SPEAKERS LIST
### 1954-1955

*Additions to List Published in July*

(*b*) *Expenses paid by Branch*
(*c*) *Expenses paid by company*
(*b*) or (*c*) *Expenses to be negotiated*

CHEMICAL CORPORATION (*c*)
54 Waltham Ave., Springfield 9, Mass.—Any Branch and special showings for company engineering staffs
B. H. GARDNER, Vice-President
Subject:
*Chemical Resistant Reinforced Plastics*
(Film: *Polyesters to Prescription*)
K. P. BELLINGER, Vice-President
H. L. MITCHELL, Manager, Laboratory
Subject:
*Chromate Finishes for Zinc, Cadmium, Brass, and Copper*

CHICAGO THRIFT-ETCHING CORP.
(*b*) or (*c*)
1555 N. Sheffield Ave., Chicago 22, Ill.—Any Branch
R. E. PETTIT
Subjects:
1. *The Story of a Name Plate*
2. *Metal Finishing in Name Plate Manufacture*

(Colored slides and large assortment of exhibits)

ELECTRIC AUTO-LITE COMPANY, Sharonville, Ohio—Any Branch
R. D. MILLER
Subject:
To be selected

GENERAL ELECTRIC COMPANY (*c*)
Electronics Laboratory, Electronics Park, Syracuse, N. Y.—Any Branch
GEORGE W. CAVANAUGH, Inorganic Chemical Unit
Subject:
*How Parliamentary Law Can Help Your Branch*

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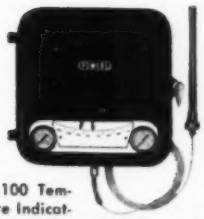

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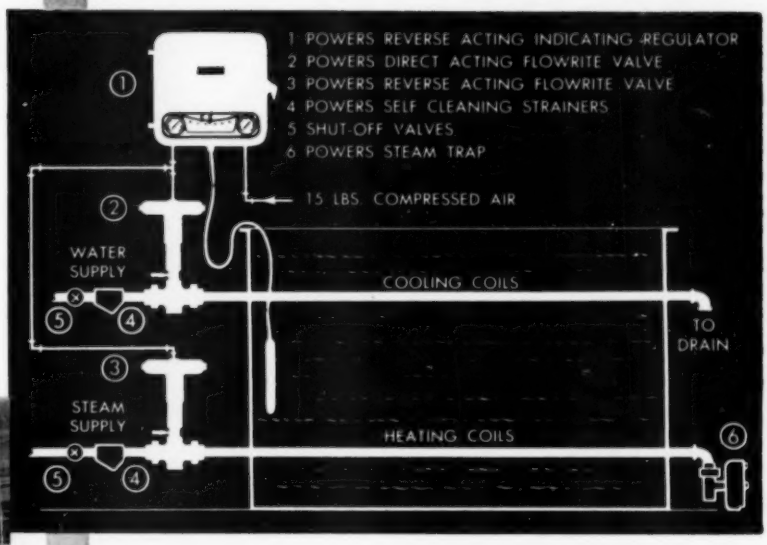


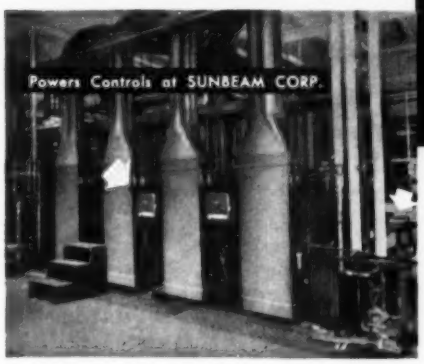


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# AES Membership Changes

### Elections

**CAPITOL DISTRICT:** Harold Lazaar
**DAYTON:** Charles T. Vannorsdell
**LOS ANGELES:** Edwin R. Calderon, Kenneth C. Johnson, Wiley A. King, Samuel Ramirez, William C. Thompson
**MILWAUKEE:** Severt Krogan
**SAGINAW VALLEY:** James C. Bennett
**SYDNEY:** J. Robinson
**SYRACUSE:** Edward D. Hall
**WESTERN ONTARIO:** Walter Mathew Koch
**MEMBER-AT-LARGE:** David K. Townley, Ogallala, Neb.; André Waldberg, Neuilly-Seine, France

### Reinstatements

**LOS ANGELES:** Mitchell Baskin
**MELBOURNE:** M. Andrews, W. Boyd, J. Chappel, A. Chesterfield, C. F. Corfe, H. Cotter, A. Ford, J. Hillhouse, B. Johnston, J. McD. Reid
**SPRINGFIELD:** John F. Horrigan
**SYDNEY:** F. Himmelhoch, H. F. Roberts, K. Sloss
**MEMBER-AT-LARGE:** Hector A. Caretta, México, D. F.; Roger Wellard, Suresnes Seine, France

### Transfers

**CLEVELAND:** Herbert Geduld, to Detroit; S. S. Johnston, from Member-at-Large; John J. Tierney, from Syracuse; Eli Shay, from Pittsburgh; Karl H. Wagner, from Pittsburgh
**DAYTON:** John G. Beck, from Cincinnati
**DETROIT:** Manuel Ben, from Saginaw Valley; Herbert Geduld, from Cleveland; Clarence G. Ozar, from Syracuse
**LOS ANGELES:** F. Bradford, to Seattle
**NEWARK:** Anthony F. Rotoli, from Syracuse; W. C. Treadwell, from Rochester
**SAGINAW VALLEY:** Manuel Ben, to Detroit
**SPRINGFIELD:** J. W. Gilchrist, to Capitol District
**SYRACUSE:** Arthur Eisner, to Capitol District; Joseph F. Kabat, to Capitol District; Norman Searles, to Capitol District; John J. Tierney, to Cleveland; Harry F. Watters, to Southern Tier
**MEMBER-AT-LARGE:** S. S. Johnston, to Cleveland; A. W. Olson, to Seattle

### Resignations

**ADELAIDE:** G. Banks, S. Brown, R. S. Davies, D. A. Kranz, A. P. Kuss, S. H. LeCornu, H. Matters, Frank McIntyre, R. T. Milner, W. Pietuszko, M. L. Tune, I. W. Wiles, H. L. Wurfel
**BALTIMORE-WASHINGTON:** Frank L. Davey
**DETROIT:** Harry Freedland, Edward G. Schroeder
**JACKSON-LANSING:** A. S. Potter, Robert Rollis
**LOS ANGELES:** Jack F. Brossart, William Crawford, Milton L. Crompton, Alphia Green
**NEWARK:** R. Rabourdin

### Suspensions

**DAYTON:** Robert J. Deisenroth, Keith Gilbert, William Hohman, Kenneth L. Martin, George L. Smith
**MELBOURNE:** W. Aarons, S. M. Anderson, M. Andrews, F. Archbold, L. Barnes, W. Boyd, D. Broadley, J. Chappel, A. Chesterfield, T. Cook, H. Cotter, B. Cox, R. Delaney, A. J. Duncan, S. Ellis, A. Ford, W. Fordham, G. Grimes, R. Handson, H. Hillhouse, A. K. Jenson, B. Johnston, J. D. McCarthy, J. McD. Reid, N. Savage, D. Walker, A. Wasley, J. White, K. Whitting
**SPRINGFIELD:** George Clark
**SYRACUSE:** Arthur Baldoni, Anthony J. Fazzone, Robert C. Taylor, Thomas H. Taylor
**TOLEDO:** Angelo Caputo, Ernest O. Gay, Stanley Ignatowski, Donald M. Miller, W. J. Miller, Joseph A. Poch, William Russell, Donald Zuck
**WESTERN ONTARIO:** J. A. L. Wilcocks

### Deaths

**DETROIT:** L. B. Eastman
**JACKSON-LANSING:** Dwight T. Ewing
**LOS ANGELES:** Edwin Williams
**NEWARK:** Jules Homa, John Kotches
**TOLEDO:** Edward J. St. Arnaud


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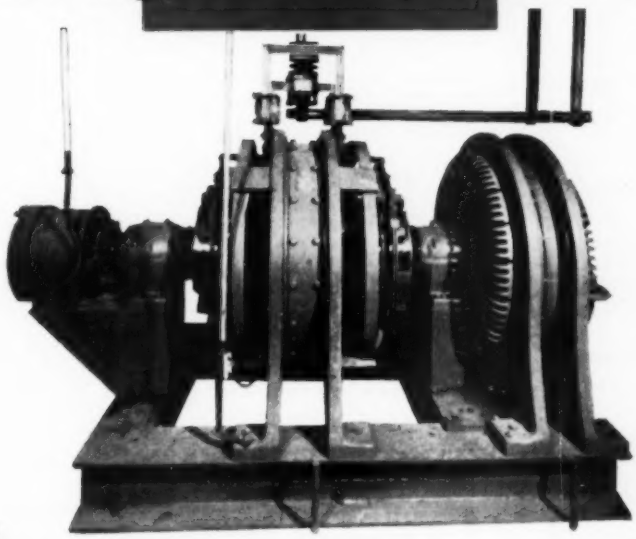

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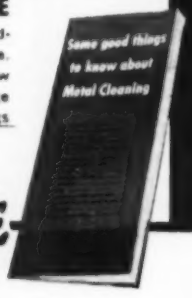


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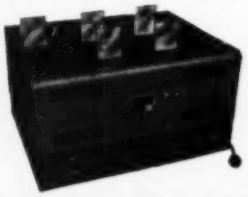

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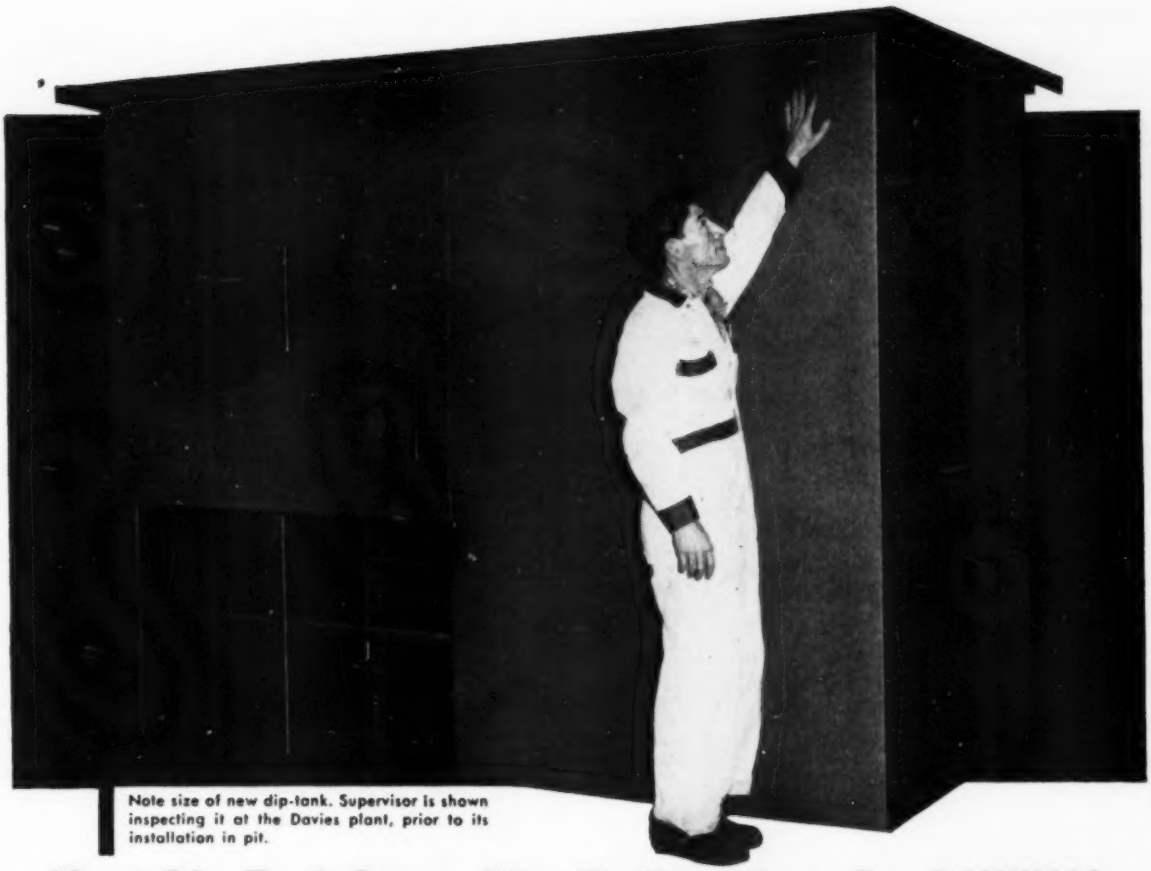

Note size of new dip-tank. Supervisor is shown inspecting it at the Davies plant, prior to its installation in pit.

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A new dip-tank, one of the largest in the U. S., was recently installed at the modern Davies plant in St. Louis.

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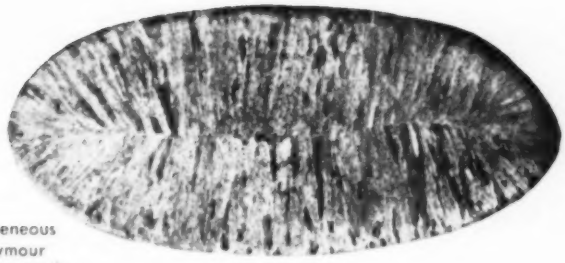

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# Future Meetings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting, Milwaukee, September 8–10, 1954.

METAL POWDER ASSOCIATION, fall meeting, Hot Springs, September 10–12, 1954.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, national meeting, Hotel Colorado, Glenwood Springs, Colorado, September 12–16, 1954.

AMERICAN CHEMICAL SOCIETY, 126th meeting, New York, September 12–17, 1954.

AES RESEARCH COMMITTEE, National Headquarters, Newark, N. J., September 17, 1954.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, annual meeting, Philadelphia, Pa., September 21–23, 1954.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1954 Exposition and Annual Convention, Cleveland Public Auditorium, September 28–October 1, 1954.

PORCELAIN ENAMEL INSTITUTE, annual meeting, White Sulphur Springs, W. Virginia, September 29–30, 1954.

PLATING EDITORIAL BOARD, Statler Hotel, Cleveland, Ohio, October 1, 1954.

STANDARDS ENGINEERS SOCIETY, annual meeting, Haddon Hall, Atlantic City, N. J., October 1–2, 1954.

ELECTROCHEMICAL SOCIETY, fall meeting, Boston, Mass., October 3–7, 1954.

NATIONAL FOUNDRY ASSOCIATION, annual meeting, Chicago, Ill., October 6–8, 1954.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, fall general meeting, Morrison Hotel, Chicago, Ill., October 11–15, 1954.

EIGHTH NATIONAL CHEMICAL EXPOSITION, Chicago, Ill., October 12–15, 1954.

NATIONAL ASSOCIATION OF CORROSION ENGINEERS, south central regional meeting, Dallas, Texas, October 12–15, 1954.

AMERICAN SOCIETY FOR METALS, National Metal Congress and National Metal Exposition, Hotel Statler, Cleveland, Ohio, October 17–23, 1954.

AES EXECUTIVE BOARD, Statler Hotel, Cleveland, Ohio, October 23–24, 1954.

FRENCH METALLURGICAL SOCIETY, autumn meeting, Paris, France, October 25–30, 1954.

MINERALOGICAL SOCIETY OF AMERICA, annual meeting, Los Angeles, Calif., November 8–10, 1954.

FEDERATION OF PAINT AND VARNISH PRODUCTION CLUBS, annual meeting, Palmer House, Chicago, Ill., November 18–20, 1954.

42ND ANNUAL AES CONVENTION AND 4TH INDUSTRIAL FINISHING EXPOSITION, Municipal Auditorium, Cleveland, Ohio, June 20–23, 1955.

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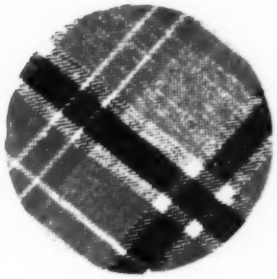

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